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July 15, 1990

Energy Research Abstracts

Abstracts 29935–32035

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

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4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
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15. **Sponsoring organization.**
16. **Contract or grant number.**
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18. **Conference title, location, and date,** if applicable.
19. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

How To Order from the Availability Sources

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
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Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
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FG02-86ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–
T1 15:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope.*

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

0103 Preparation

Refer also to citation(s) 29980, 30493

29935 (DOE/FE–0175P) **Coal Preparation Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 22p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010271. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall goal of the Coal Preparation Program is to provide the scientific and engineering knowledge base for industrial sector use in producing economically competitive and environmentally acceptable clean coal products with significantly reduced ash and sulfur contents. Coal preparation processes should be capable of removing enough of the undesirable components from coal and improving its handling characteristics so that the product coal is both technically and economically viable as a competitor with petroleum-derived fuels and natural gas in many applications. Coal preparation technologies made possible through the knowledge base developed by the program are applicable to a wide variety of bituminous and low-rank coals, and reduce the variability among clean coal products from various raw coals so that the range of potential end uses for each raw coal is significantly increased. This report provides a technology description and discusses program strategy of the coal preparation program. 1 fig.

29936 (DOE/PC/89908–T1) **Engineering design and analysis of advanced physical fine coal cleaning technologies: Technical progress report No. 5, February 1990.** Gallier, P.W. Aspen Technology, Inc., Cambridge, MA (USA). 20 Mar 1990. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89908. Order Number DE90009557. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Previously, the work was focused on the modeling of gravity separation processes, the testing of the interpolation algorithm, and the design and program coding of ASPEN PLUS system modifications. This quarter, ICF KE received the VAX FORTRAN version of the interpolation routine developed by Klima and Luckie on February 8. ICF KE began testing of the routine with washability data taken from EPRI's Coal Quality Information Book (CQIB). CQIB is a comprehensive source of washability data for major domestic coal seams. The structure of the program allows the user to select several interpolation criteria. The program successfully expanded several washability datasets from the CQIB (Illinois No. 6 coal) to the required simulator size and gravity lengths by the square root of 2 and 0.05 intervals, respectively. From engineering judgment, the data reflected reasonable expansion criteria and met an overall mass and attribute balance. Test with other coals (i.e., Pittsburgh No. 8), however, were not as successful. 1 fig., 1 tab.

29937 Approaches to cleaning and conversion of coal through bioprocessing. Dugan, P.R. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); McIlwain, M.E.; Quigley, D.; Stoner, D.L. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Bioprocessing of coal is an embryonic technology. The potential applications of this technology for enhancing the use of coal are sizable. The success of current studies are sufficient to suggest that in the future, bioprocessing will be used to produce cleaner coals, convert coal to specialty chemicals and fuels, and to offset the impact of coal combustion derived gases on the environment. The potential use of solubilized coal, particularly lignites, as a means of removing (toxic) hazardous metals from waste streams deserves attention by the coal industry at this time. The future of coal bioprocessing is promising, but for the technology to be successful, it requires more research and greater industrial awareness. This article discusses approaches to cleaning and conversion of coal through bioprocessing.

29938 Development of the LICADO coal cleaning process. He, D.X. (Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering); Araujo, G.; Morsi, B.; Klinzng, G.; Venkatadri, R.; Chiang, S.H.; Cooper, M.H. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). Grant 486-048. (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper describes the LICADO process which is surface-property driven process in which the liquid CO_2_ water interface is used to the differentiation and separation between coal and mineral matter. The initial tests were conducted in a glass cylinder (0.85 inch I.D.) enclosed in a high pressure vessel. This was later replaced by a batch research unit (BRU) composed of two 2-inch high pressure vessels connected by a ball valve. Semi-continuous experiments were then carried out in a 4-inch research development unit (RDU). The results of these experiments provided a valuable data base for the design and operation of a fully automated continuous research unit (CRU).

29939 Trace element removal during physical and chemical coal cleaning. Norton, G.A. (Ames Lab., and Iowa State Mining and Mineral Resources Research Institute, Iowa State Univ., Ames, IA (US)); Markuszewski, R. *Coal Preparation (Gordon and Breach) (USA),* 7(1): 55-68 (1989). DOE Contract W-7405-ENG-82.

Trace elements in coal are detrimental from both an environmental and a technological perspective. Since most trace elements in coal are associated primarily with the mineral phases, they are often amenable to removal by conventional physical coal beneficiation methods. However, these methods generally are not adequate for removing those trace elements which are associated with the organic matrix or which are very finely disseminated. Thus, chemical treatments may be necessary for removal of these trace components. Data from a variety of studies indicate that cleaning by concentrating tables, jigs, heavy-media cyclones, hydrocyclones, froth flotation, and oil agglomeration could effectively remove many trace elements from some coals. However, trace element removal efficiencies varied widely between coals. Because cleaning efficiencies are strongly coal-dependent, conclusions regarding the relative effectiveness of various cleaning techniques are difficult to draw since different coals were used among studies.

29940 Effect of humic substances on the flotation response of coal. Lai, R.W. (Pittsburgh Energy Technology Center, U.S. Dept. of Energy, Pittsburgh, PA (US)); Wen, W.W.; Okoh, J.M. *Coal Preparation (Gordon and Breach) (USA),* 7(1): 69-84 (1989).

This study investigated the generation of humic substances from the coal and the coal surface, and evaluated the effect of humic substances on the surface property of coal. The humic substances in aqueous solution were readily adsorbed on the surface of fresh coal. The adsorption affects the surface hydrophobicity of the coal and, hence, the flotation recovery of coal. The adsorption of humic substances is maximum at neutral pH and diminishes toward both the alkaline pH and the acid pH. This effect is reflected in the flotation responses of the fresh coal. Solutions of humic substances were oxidized with oxygen gas and ozone. The oxidation of humic substances in solution resulted in an adsorption that greatly enhanced the hydrophilicity of the coal and thus impaired the floatability of the coal. On the other hand, the ozonation of humic substances in solution resulted in the decomposition of humic substances and an improvement in the flotation response of the coal. Direct oxidation and ozonation of coal surface decreased the hydrophobicity of the coal, which resulted in a decrease in the flotation response.

0104 Processing

Refer also to citation(s) 29935, 29937, 29939, 29940, 29967, 29970, 29972, 29976, 29981, 29985, 29986, 29989, 29996, 30055, 30286, 30317, 30493

29941 (CONF-891081–, pp. 269-288) **Coal pretreatment, chemistry and technology: Preliminary results.** Ross, D.S. (SRI International Menlo Park, CA (USA)); Hirshon, A.S.; Brandes, S.D.; Pollack, N.R.; Warzinski, R.P. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

This paper presents the research results on water/steam pretreatment of coal obtained by three independent research groups, as well as preliminary results of a collaborative effort between the Pittsburgh Energy Technology Center and SRI International. Research has been conducted on the effects of hydrothermal pretreatment of coal and the benefits that can develop for subsequent conversion processes, utilizing both steam and liquid water media at elevated temperatures. Bienkowski et al have found that water vapor/ammonia pretreatments enhance liquefaction, and Brandes and Graff have reported increased yields of liquids in steam pyrolysis following a steam treatment at 340°C.

29942 (CONF-900531–1) **Solubilization of coal by reducing enzymes in organic and aqueous media.** Scott, C.D.; Woodward, C.A.; Faison, B.D. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From 1. international symposium on the biological processing of coal; Orlando, FL (USA); 1-3 May 1990. Order Number DE90010432. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Biocatalytic systems utilizing either living organisms or enzymes in vitro have been shown to enhance the solubilization of coal. Recent research has included the investigation of anaerobic solubilization of coal enhanced by reducing enzymes dissolved in organic solvents under a hydrogen atmosphere. Organic solvents are particularly attractive since the resulting solubilization products will be in a medium that should be more suitable for further processing. It has been shown that the solubilization and stability of enzymes in organics can be enhanced by chemical complexation with a modified polyethylene glycol using two different attachment techniques. Bituminous and subbituminous coal samples size-reduced to 100 to 170 mesh have been used in shake flasks or small fluidized-bed bioreactors. All of the experiments were made at ambient pressure and temperatures in the range of 20 to 40°C. The most interesting results occurred with the use of modified hydrogenase in benzene, where it was shown that bituminous coal solubilization in excess of 20% could be achieved at very mild conditions. The resulting products are relatively nonpolar, with spectral properties similar to aromatic compounds. Over 60% of the solubilization product apparently had a boiling point less than 300°C. 14 refs., 2 figs., 4 tabs.

29943 (DOE/CH/00016–2728) **Mild gasification of coal: Annual technical progress report, October 1987–September 1988.** Sundaram, M.S.; Fallon, P.T.; Steinberg, M. Brookhaven National Lab., Upton, NY (USA). Jan 1989. 124p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-76CH00016. Order Number DE89011673. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The objective of this initial year's mission-oriented multi-year program is to develop a process chemistry data base for the mild gasification of coal with emphasis on eastern bituminous coal. One important objective of this program was to obtain the trends in product formation from different coals as a function of several process variables which included temperature, pressure, coal particle residence time, coal flow rate, type of additives such as lime, limestone, silica flour and ash in a short period of time. This was achieved by a careful development of a test matrix using a fractional factorial statistical design. The equipment used was the Brookhaven National Laboratory (BNL) combination stirred moving-bed, entrained-tubular reactor which is capable of processing 2 to 3 pounds of coal per hour. A Wellmore Kentucky No. 8 bituminous coal, a Pittsburgh No. 8 bituminous coal and a Mississippi lignite with particles having a size of 150 μm or less were selected for this study. The mild gasification experiments were conducted at temperatures from 550° to 650°C at nitrogen sweep gas pressures of 15 to 50 psi and residence times of 0.1 to 2 min. The coal flow rate was 0. 4 to 1.0 lb/hr and the concentration of the lime additives was 0 to 10% by weight of the dry coal feed. All variables were tested at two different levels, low and high, corresponding to the above ranges of the variables. A rapid calculation of the main effects and interactions was made using Yate's algorithm and the significance of the effects was determined from the normal probability plots. 10 refs., 26 figs., 11 tabs.

29944 (DOE/FE–0184P) **Surface Coal Gasification Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 28p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010266. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the Surface Coal Gasification Program is to advance the state-of-the-art of the surface coal gasification technology to optimize its potential for use in the commercialization of more viable or advanced gasification systems through the development of promising concepts that have significant potential to accomplish the following: reduce capital costs of the system, reduce system operating costs, reduce facility construction time, and minimize the potential for any adverse environmental impact caused by these facilities. A technology description and market applications discussion is provided in this report. 4 figs.

29945 (DOE/MC/23075–2814) **Measurement and modeling of advanced coal conversion processes: 13th quarterly report, October 1–December 31, 1989.** Solomon, P.R. (Advanced Fuel Research, Inc., East Hartford, CT (USA)); Serio, M.A.; Hamblen, D.G.; Smoot, L.D.; Brewster, B.S. Advanced Fuel Research, Inc., East Hartford, CT (USA). Feb 1990. 123p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23075. Order Number DE90010628. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The overall objective of this program is the development of predictive capability for the design, scale up, simulation, control and feedstock evaluation in advanced coal conversion devices. The foundation to describe coal-specific conversion behavior is AFR's Functional Group (FG) and Devolatilization, Vaporization, and Crosslinking (DVC) models, developed under previous and on-going METC sponsored programs. These models have demonstrated the capability to describe the time dependent evolution of individual gas species, and the amount and characteristics of tar and char. The combined FG-DVC model will be integrated with BYU's comprehensive two-dimensional reactor model, PCGC-2, which is currently the most widely used reactor simulation for combustion or gasification. The program includes: (1) validation of the submodels by comparison with laboratory data obtained in this program, (2) extensive validation of the modified comprehensive code by comparison of predicted results with data from bench-scale and process scale investigations of gasification, mild gasification and combustion of coal or coal-derived products in heat engines, and (3) development of well documented user friendly software applicable to a "workstation" environment. Progress is reported.

29946 (DOE/MC/23161–2806) **Aerodynamic drag characterization and deposition studies of irregular particles: Part 3, Analysis of flow and temperature field inside the Combustion Deposition Entrained Reactor (CDER): Final report.** Celik, I.; Katragadda, S.; Nagarajan, R. West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. Jan 1990. 95p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG21-86MC23161. Order Number DE90000466. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

An experimental and numerical analysis was performed of the temperature and flow field involved in co-axial, confined, non-reacting heated jets in a drop tube reactor. An electrically heated 2-inch (50.8 mm) diameter drop tube reactor was utilized to study the jet characteristics. Profiles of gas temperature, typically in the range of 800–1600 K were measured in the mixing zone of the jet

with a K-Type thermocouple. Measured temperatures were corrected for conduction, convection, and radiation heat losses. Because of limited access to the mixing zone, characterization of the flow field at high temperatures with laser doppler or hot wire anemometry were impractical. A computer program which solves the full equations of motion and energy was employed to simulate the temperature and flow fields. The location of the recirculation region, the flow regimes and the mixing phenomena were studied. The wall heating, laminar and turbulent flow regimes were considered in the simulations. The predictions are in fairly good agreement with the corrected temperature measurements provided that the flow is turbulent. The results of this study demonstrate how a numerical method and measurement can be used together to analyze the flow conditions inside a reactor which has limited access because of very high temperatures. 37 refs., 37 figs., 8 tabs.

29947 (DOE/PC/79813–T3) **Advanced studies of biological indirect liquefaction of coal: Topical report on Task 3: Culture optimization.** Arkansas Univ., Fayetteville, AR (USA). Dept. of Chemical Engineering. Jan 1990. 118p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC79813. Order Number DE90007647. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Conditions for the growth and production of ethanol by C. ljungdahlii from CO, CO_2 and H_2 in synthesis gas have been determined. Reaction stoichiometric equations for the production of both acetate and ethanol from the components of synthesis gas have been quantified. A defined mineral medium has been developed for the culture and the effect of physical parameters such as yeast extract concentration and H_2 partial pressure have been determined. Mass transfer and kinetic parameters have been found determined for the culture to aid in process design and scale-up. Finally, both ethanol and acetate in high concentrations have not been found to be inhibitory to culture performance. 15 refs., 61 figs., 3 tabs.

29948 (DOE/PC/79813–T4) **Advanced studies of biological indirect liquefaction of coal: Topical report on Task 2: Elimination of acetate as a product from CO utilization.** Arkansas Univ., Fayetteville, AR (USA). Dept. of Chemical Engineering. Jan 1990. 159p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC79813. Order Number DE90007648. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Numerous batch and continuous studies have been carried out in an effort to eliminate or at least minimize the production of acetate in favor of ethanol from CO, H_2 and CO_2 in synthesis gas by C. ljungdahlii. The addition of alternate nutrient sources and reducing agents and a change in physical parameters such as pH have been largely responsible for vast increases in the product ratio, ethanol concentration and ethanol productivity of the culture. Starting from an early batch product ratio of 20 parts acetate to 1 part ethanol, the culture has recently shown the ability to produce only ethanol from CO, CO_2 and H_2 continuous culture when using a two-stage CSTR system. Specific ethanol productivities of more than 300 mmol ethanol/g cell-day have been achieved and ethanol concentration of 3-4 g/L have been shown. 28 refs., 82 figs., 7 tabs.

29949 (DOE/PC/80502–T17) **Interactive chemistry of coal-petroleum processing: Quarterly report, December 16, 1989–March 15, 1990.** Curtis, C.W.; Guin, J.A.; Tarrer, A.R. Auburn Univ., AL (USA). Dept. of Chemical Engineering. [1990]. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80502. Order Number DE90009794. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A catalytic activity of nickel, a trace metal indigenous to residuum used in coprocessing of coal and petroleum residuum, was investigated in hydrogenation and heteroatom removal reactions using model systems naphthalene, tetralin, indene, indan, o-cresol, benzothiophene, benzofuran, quinoline, and indole at coprocessing conditions. Hydrocarbons and heteroatomic species of S, N, and O having similar chemical structures to some compounds present in coal and residuum were used as models. The active Ni catalyst was generated in situ by thermal decomposition of organic nickel complexes, all of which were active for hydrogenation of the models selected except for nickel naphthenate. The active Ni promoted ring saturation in aromatic and heteroatomic compounds rather than ring hydrogenolysis or heteroatom removal. 22 refs., 2 figs., 6 tabs.

29950 (DOE/PC/88812–T6) **Process and analytical studies of enhanced low severity co-processing using selective coal pretreatment: Quarterly technical progress report, December 1989–February 1990.** Baldwin, R.M.; Miller, R.L. Colorado School of Mines, Golden, CO (USA). Dept. of Chemical Engineering and Petroleum Refining. [1990]. 25p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88812. Order Number DE90009556. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objectives of the project are to investigate various coal pretreatment techniques and to determine the effect of these pretreatment procedures on the reactivity of the coal. Research during the past quarter focused on a comparison of the effect of mild alkylation and addition of a dispersed catalyst (chlorine) on coal reactivity under direct hydroliquefaction reaction conditions. Reactivity of coals that had been alkylated by both Sternberg and Liotta recipies were compared to a coal that was very mildly alkylated and chlorinated via use of HCl as an alkylation catalyst. Results indicated that the reactivity enhancement noted via either the Sternberg or Liotta procedures was a function of the number of alkyl groups added. Presence of a dispersed catalyst was found to be more effective than alkylation in terms of net reactivity enhancement. 14 refs., 7 figs., 3 tabs.

29951 (DOE/PC/89759–T1) **Rank dependence of tar evolution: Quarterly report, 1 October 1989–1 January 1990.** Freihaut, J.D.; Proscia, W.M. United Technologies Research Center, East Hartford, CT (USA). Feb 1990. 71p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89759. Order Number DE90009839. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Six coals have been selected as the focus of this experimental effort. A series of experiments utilizing the selected coals shall be conducted in idealized reactors in such a manner as to allow a determination of the rank sensitivity of tar evolution kinetics. A comprehensive examination of the gas phase secondary reaction kinetics of tars, resulting from the pyrolysis of coals of varying ranks shall be performed. The range of tars and other materials produced as a result of pyrolysis shall be examined for various important chemical and physical properties including molecular weights, vaporization temperatures, and calorific values. The influence of interphase mass transfer resistance on tar evolution rates shall be determined. Experiments shall be performed to establish the effect of ambient oxygen concentration on the evolution and conversion of fuel bound nitrogen resulting from the tar evolution process. An integrated experimental and modeling effort shall be conducted to test critical hypothesis found in existing devolatilization models with the objective of developing a reliable model for tar evolution from coals of various ranks. 11 refs., 18 figs., 5 tabs.

29952 (DOE/PC/89851–T2) **Cooperative research in coal liquefaction infratechnology and generic technology development: Quarterly report, August 1, 1989–October 31, 1989.** Huffman, G.P.; Sendlein, L.V.A. Consortium for Fossil Fuel Liquefaction Science, Lexington, KY (USA). [1990]. 115p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89851. Order Number DE90009841. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A summary of research is presented on coal liquefaction. Programs include: bioprocessing of coal, University of Kentucky; materials characterization study of coal liquefaction processes, University of Kentucky; novel approaches to catalysis in coprocessing and in direct liquefaction of coal, University of Pittsburgh; liquefaction research in pyrolysis, catalysis and coal dissolution, West Virginia University; enhanced reactivity and selectivity in coal liquefaction and coprocessing systems, Auburn University; integrated liquefaction/characterization, University of Utah; basic process/resource evaluation task, center for applied energy research; and project integration and database development, University of Kentucky.

29953 (DOE/PC/90007–T1) **Modified ferrisilicates for synthesis gas conversion: Final report.** Szostak, R.; Nair, V.

Georgia Inst. of Tech., Atlanta, GA (USA). Research Inst. Jan 1990. 545p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90007. Order Number DE90009553. Available from NTIS, PC A24/MF A01 - OSTI; GPO Dep.

Iron silicate (or ferrisilicate) molecular sieves with the ZSM-5 structure have been synthesized with SiO_2/Fe_2O_3 varying from 20 to infinity (specifically 20, 50, 90, and 200) utilizing techniques developed in our laboratory. These materials were subsequently modified using combined thermal and hydrothermal treatment which yielded novel bifunctional iron oxide containing molecular sieves. Detailed characterization, both physical and catalytic, revealed the presence of very small clusters of iron oxide highly dispersed within the pore system of the ZSM-5 crystal structure. The size of the clusters formed and their location within the pores was found to be very sensitive to the SiO_2/Fe_2O_3 ratio of the parent material, the temperature, the time of hydrothermal treatment and the quality of the molecular sieve crystals. As synthesis gas catalysts, these properly prepared modified iron silicates were shown to be highly active despite their low iron content and exhibited the desired selectivity for production of C8 hydrocarbons. 228 refs., 108 figs., 37 tabs.

29954 (PB–90-172644/XAB) **Energy Field Institute III follow-up workshop.** Hepworth, J.C. Colorado School of Mines, Golden, CO (USA). 1989. 46p. Available from NTIS, PC A03/MF A01.

A one-day field program was planned and resource persons were selected to talk about synthetic-fuel-technology alternatives during an evening program. The intent of the evening program was to include additional perspectives to synthetic fuel technology research. Subjects addressed were: coal characteristics and synthetic fuel technologies; process technology; and some potential problems associated with achieving a production goal of one million barrels per day of coal liquids by 1990. The substance of the second day of the Workshop was provided by the participants who volunteered for roles in the program.

29955 (PB–90-178328/XAB) **Environmental monitoring plan for the Dow Syngas Project. Quarterly report: Third quarter, 1989. Report for 1 July-30 September 1989.** LeBlanc, G. Louisiana Gasification Technology, Inc., Plaquemine, LA (USA). 30 Nov 1989. 61p. Available from NTIS, PC A04/MF A01.

The Dow Syngas Project design is a high-temperature entrained-flow slagging type gasifier that began operating in 1987. Dow agreed to comply with existing environmental regulations and to develop an Environmental Monitoring Plan (EMP) incorporating supplemental monitoring in areas of potential environmental and health concern, relative to synthetic-fuels facilities. The phases of monitoring in the EMP will test parameters of interest in air, water, and solid waste for evaluating plant uncertainties relative to replication of synthetic-fuels plants.

29956 Biotechnology and mining: Present application and future prospects. . Wichlacz, P.C. (Idaho National Engineering Lab., Idaho Falls, ID (USA)). pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

The application of biotechnology in mining and mineral industries discussed in this paper. It is currently practiced for the solubilization of copper and uranium contained in low-grade ores. The potential exists for increasing the use of biotechnology in mineral processing. Promising areas for research and industrial development include the concentration and solubilization of metal values, modification of ores to facilitate processing, and coal desulfurization. Modification and control of specific microbial characteristics, including metal tolerance, rate and specificity of direct mineral sulfide oxidation, and rate of iron oxidation are feasible and may be advantageous to metal leaching. The use of biotechnology for the efficient concentration of valued metals from waste streams and hydrometallurgical leaching processes is promising. The use of cells, proteins, and extracellular polymers for binding metals holds the potential for concentrating metals from dilute solutions. Limitations to increased us of biotechnology in mineral leaching include the relative lack of knowledge with regard to the effects of microbial activity, the extreme nature of the environment (i.e., low pH, high cation concentration) associated with mineral leaching and engineering design. Biological metal concentration is presently limited by a lack of information regarding specific applications, engineering design and comparison to conventional metal recovery systems.

29957 Potential for transportation fuels produced by mild gasification. Babu, S.P. (Institute of Gas Technology, Chicago, IL (USA)); Knight, R.A.; Longanbach, J.R.; Wootten, J.M. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The time is fast approaching when imports will, for the first time, constitute half of U.S. domestic petroleum supply. Although not economically catastrophic in itself, the energy import bill represents the single largest element of our nation's trade deficit, and the singly largest potential source of savings if we could produce transportation fuels from coal, our most abundant and underused energy resource. The use of coal as a source of liquid fuels, principally kerosene, was first explored in the mid 1880's. Even though the first concerted effort to develop a coal-based synthetic fuels industry was initiated during the 1920-1923 oil shortage, the deployment of coal conversion technologies was, then and several times thereafter, stopped by new supplies of conventional fuels. The past R&D efforts were directed toward the production of premium fuels – diesel fuels and motor and aviation gasoline – with the hope that the high-end-use products would ensure commercial success. The high-temperature, high-pressure processes required were capital-intensive, and the resulting products could not compete with petroleum-derived fuels.

29958 Hydrothermal pretreatment effects on co-processing. Ross, D.S. (SRI International, Menlo Park, CA (USA)); McMillen, D.F.; Malhotra, R.; Hirschon, A.S.; Tse, D.S. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The authors are conducting studies on the effects of hydrothermal pretreatment of coal on coprocessing yields and product quality (US DOE Contract No. DE-AC22-88PC 888 02). This paper reports on those studies. The term hydrothermal refers to aqueous medial heated in the critical point of water (374°C) under conditions at the liquid/vapor boundary where a liquid phase is maintained. The term is also applied to supercritical water at liquid-like densities. The work is part of a larger program on the effects of hydrothermal media on coal overall.

29959 UOP co-processing developments. Nafis, D.A. (UOP, Inc., Des Plaines, IL (USA)); Fullerton, H.E.; Gatsis, J.G.; Miller, M.A. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper introduces a molybdenum-based slurry co-processing catalyst (K6.2). Switching to the new catalyst is expected to reduce overall catalyst costs by a factor of 2.5 and give equivalent IRR's to K2.0 at $7/bbl lower crude price levels. Optimum heptane insoluble conversion for the new catalyst occurs at about 420°C.

29960 Advanced concept for the production of value-added co-products through a mild coal gasification process. Chu, C.I. (Coal Technology Corp., 103 Thomas Road, Bristol, VA (US)); Gillespie, B.L. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The primary objective of this project is to develop the technology for a selected continuous mild coal gasification process which will yield quantities and properties of value-added co-products that can be economically produced on a commercial scale in the near future.

29961 Fuel bound nitrogen evolution during coal devolatilization/pyrolysis: Similarities and differences with coal

rank characteristics. . Freihaut, J.D. (United Technologies Research Center, East Hartford, CT (USA)); Proscia, W.M.; Seery, D.J. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916--: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

A entrained flow reactor was utilized to examine the fuel bound nitrogen evolution processes associated with rapid coal devolatilization/pyrolysis processes. The heat transfer conditions of the reactor can be selected to either maximize heavy hydrocarbon yields, while minimizing gas phase secondary reactions of these species, or to maximize total volatile yields, and thereby introduce secondary pyrolysis reactions. On-line analysis of the IR active light gases is performed. An extensive aerosol phase separation system with a metallic filter system is employed to separate and isolate tar species from char species. Elemental composition measurements of the char and tar species coupled to the on-line analysis system enables nitrogen concentration determination of all the major devolatilization products. These determinations, coupled to ash tracer techniques for determination of total volatile yields, allows tar yields to be determined. FBN closure follows from the sets of measurements. Fuel bound nitrogen (FBN) evolution behavior observed in this reactor system is compared and contrasted to behavior observed in other systems, having lower and greater heat transfer rates to similar peak temperatures. The FBN to NO_x precursor reactions as a function of coal type, particle and gas temperature regimes, and reactor heating rate conditions is examined.

29962 Chemical comminution and deashing of low rank coals. Quigley, D.R. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Wiebe, S.R. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC07-76ID01570. (CONF-890916--: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Low rank coals were found to be soluble in dilute NaOH solutions. Solubilities of coals were highest in coals containing >20% oxygen. Solubilized coals could easily be separated from insoluble mineral inclusions and recovered by the addition of calcium at concentrations greater than 10nM. The potential use of this treatment for coals processing is discussed.

29963 Catalysts for Fischer-Tropsch. Srivastava, R.D. (Burns and Roe Services Corp. (US)); Rao, V.U.S.; Cinquegrane, G.; Stiegel, G.J. *Hydrocarbon Processing (USA),* 69(2): 59 (Feb 1990).

The slurry-phase Fischer-Tropsch (F-T) process has attracted considerable attention recently. The process can make liquid fuels by reacting hydrogen-lean synthesis gas produced from modern energy-efficient gasifiers. continuing assessment of Fischer-Tropsch Synthesis (FTS) has a high priority within an indirect liquefaction program, a part of the liquid fuels program sponsored by the U.S. Department of Energy (DOE) and executed by the Pittsburgh Energy Technology Center (PETC). Funding for the indirect liquefaction program in 1990:0090 is anticipated to be about $8.5 million compared to $6.6 million in 1989 and a like amount in the year before. The studies within the program are conducted by industry, universities, national laboratories and in-house PETC research and development. This article reviews preparation and properties of iron-based catalysts, including recent patent activities and in-depth process analysis of slurry-phase FTS. The review provides an analysis of Fischer-Tropsch catalyst research and development trends and describes options to increase selectivity for iron-based catalysts in a slurry phase.

29964 An overview of the chemistry of the molten-caustic-leaching process. Gala, H.B. (Burns and Roe Services Corporation, Pittsburgh, PA (US)); Srivastava, R.D.; Rhee, K.H.; Hucko, R.E. *Coal Preparation (Gordon and Breach) (USA),* 7(1): 1-28 (1989).

The molten-caustic leaching (MCL) process is quite effective in its ability to remove both organic and pyritic sulfur, mineral matter, and trace elements from coal. This paper reports how the chemistry of various reactions taking place in the process has been examined by several researchers. For example, Ames Laboratory of Iowa State University is actively studying the chemistry of MCL desulfurization and reagent regeneration reactions, and researchers at the U.S. Department of Energy's Pittsburgh Energy Technology Center are examining the reactions of molten caustic with the organosulfur compounds present in coal. As a result of these research efforts, reactions of mineral pyrite, benzothiophene, and minerals commonly found in coal (quartz, illite, etc.) with molten caustic are well characterized.

29965 Decomposition of coal model compounds during simulated chemical coal cleaning with molten hydroxides. Nowak, M.A. (U.S. Dept. of Energy, Pittsburgh Energy Technology Center, Pittsburgh, PA (US)); Utz, B.R.; Fauth, D.J.; Friedman, S.; Knoer, J.P.; Gessner, N. *Coal Preparation (Gordon and Breach) (USA),* 7(1): 29-36 (1989).

Coal model compounds, such as dibenzothiophene, its analogs and the hydroxylated derivatives of these compounds, were treated with molten hydroxides to evaluate the importance of nucleophilicity for the different alkali-metal hydroxides. The soluble hydroxylated model compounds were decomposed and desulfurized by RbOH or CsOH at lower temperatures and in less time than when decomposed by KOH or NaOH, indicating that molten hydroxides have varying degrees of nucleophilicity, the progression of nucleophilicity being CsOH > RbOH ≥ KOH > NaOH. The discrepancy of these results with previously published studies, suggesting NaOH is as effective as KOH in desulfurizing coal, is discussed. Increased solubility of the hydroxylated derivatives in molten hydroxide led to faster reaction rates under homogeneous reaction conditions. Aryl ethers decomposed more readily than did aryl sulfides.

29966 Decaking of coal or oil shale during pyrolysis in the presence of iron oxides. Khan, M.R. To U.S. Dept. of Energy, Washington, DC. USA Patent 4886521/A/. 12 Dec 1989. Filed date 5 May 1988. USA Patent Application 7-190,429. Int. Cl. C10L 5/00. vp.

This patent describes a method for producing a fuel from the pyrolysis of coal or oil shale. It comprises: pulverizing coal or oil shale, pulverizing iron oxide, subjecting the pulverized mixture to a mechanical load, and heating the mechanically loaded mixture to pyrolysis temperature in a gas atmosphere which is substantially inert to the mixture, so as to substantially prevent the mixture from swelling, to form a product fuel.

0105 Products and By-Products

Refer also to citation(s) 29958, 29960, 30596

0106 Properties and Composition

Refer also to citation(s) 29939, 29945, 29951, 29958, 29960, 29961, 29962, 29984, 30011, 30317, 30898

29967 (CONF-900402--6) **Use of model compounds in coal structure and reactivity studies.** Winans, R.E. (Argonne National Lab., IL (USA)); Hayatsu, Ryoichi; Carrado, K.A.; Botto, R.E.; Squires, T.G. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990. Order Number DE90009710. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The interpretation of data from chemical and thermal reactions of coals is often facilitated and can be strengthened by investigating analogous reactions in appropriate model systems. While coal models have ranged from small molecules to polymers to synthetically coalified biomolecules and biomacromolecules, it appears that there are dangers in extrapolating the behavior of small. Soluble molecules to that of solid coal. We have found that polymers and synthetic coals are much more appropriate models for coal behavior. In the present report, pyrolysis data from the latter models and coals will be compared and contrasted. 8 refs., 4 figs., 2 tabs.

29968 (DOE/PC/88861--T18) **Interactions of sulfur-containing compounds with transition metal clusters and metal surfaces III: Final report, January 1--December 31, 1988.** Dunkerton, L.V. (Southern Illinois Univ., Carbondale, IL (USA). Dept. of Chemistry and Biochemistry); Hinckley, C.C.; Tyrrell, J.;

Robinson, P.D. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Chemistry and Biochemistry. [1989]. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-88PC88861. Order Number DE90010591. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Reactions of sulfur-containing substituted dibenzothiophenes with transition metals have been continued with emphasis on the nature and type of metal-sulfur bonding, including the effect of the metal on the adjacent bond lengths. The structure of (η^5-cyclopentadienyl) carbonyl 4-P-diphenyl-phosphine dibenzothiophene iron (II) iodide has been determined by x-ray diffraction. The synthesis of μ2 bridged dinuclear Fe(II) complex with 4-thiomethyldibenzothiophene is reported. The structure of the complex dicyclopentadienyl dicarbonyl di-iron dithiomethyl dibenzothiophene has been determined by ^{1}H NMR, ^{13}C NMR, FTIR, FABMS, and elemental analysis. Interestingly, ^{13}C NMR and ^{1}H NMR showed significant shift after complex formation. The structure of 4-S-Methyldibenzothiophene has been determined by x-ray diffraction. The geometry of 4-S-Methyldibenzothiophene is orthorhombic with planar dibenzothiophene having the methyl sulfide substituent out of plane of the ring. It is hoped through these studies to increase our understanding of the role in-situ metal sulfides play in the coal desulfurization process and to improve predictions of new routes to coal desulfurization. 15 refs., 6 figs., 7 tabs.

29969 (DOE/PC/89904–T6) **Modification of coal surfaces with methyl radicals: Final report, January 1, 1989–August 31, 1990.** Smith, G.V.; Wiltowski, T.; Wiltowska, T.; Myszka, E.; Zhao, Keji. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Chemistry and Biochemistry. Mar 1990. 26p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90010587. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of this project is to develop a new method for modifying the surface of coals under mild conditions. Objectives are to determine the conditions for using physical methods for generating radicals from methane to modify the surfaces of coals and to analyze the surface of the modified coals. Results will be compared to those obtained from experiments in which methyl radicals are generated by chemical methods. Experiments were conducted on IBCSP coal No. 5 with mixtures of methane and oxygen with and without electric discharge generated in-stream by an Electro-Technic Products model BD-10A Generator. Yields of BTX (benzene, toluene, and the xylenes), medium hydrocarbons (C_7-C_{10}), and naphthalenes were measured. The effect of weathering on the production of valuable chemicals (BTX, medium hydrocarbons, and naphthalenes) was investigated by preoxidizing IBCSP coal No. 5 at 25°C and 70°C and treating the coal with CH_4/O_2(2.54%) at 450°C, 500°C and 550°C. 20 refs., 11 figs., 5 tabs.

29970 (DOE/PC/89904–T7) **Microbial removal of organic sulfur from coal (bacterial degradation of sulfur-containing heterocyclic compounds): Final report, January 1, 1989–August 31, 1990.** Klubek, B. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Plant and Soil Science. Mar 1990. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90010588. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The presence of substantial levels of sulfur in coal is a major source of air pollution, and considerable efforts are being made to devise a cost-effective way of removing the sulfur. One method is to mutate a laboratory species, Escherichia coli, an organism which is genetically well-understood and whose pathways for the metabolism of sulfur-containing amino acids have been extensively investigated. Such thiophene degraders can be genetically analyzed and the genes involved can be cloned in order to amplify their products. A second approach is the development of naturally occurring bacteria capable of thiophene desulfurization. Characterization of the degradation of model compounds, enhancement of the desulfurization potential of the isolated strains via mutagenesis, and studies with crushed coal will comprise the approach used in this study. The screening of soil isolates for the potential to desulfurize thiophenic and other sources of organic sulfur will identify the best strains for the microbial removal of organic sulfur from coal. Ultimately, the genes responsible for thiophene degradation by the isolated strains will be transferred to an E. coli strain, creating a single organism capable of degrading a broad spectrum of thiophene compounds. 24 refs., 3 figs., 2 tabs.

29971 (DOE/PC/89904–T8) **Coal-water interaction and preparation of dewatered ultrafine clean coal: Final report, January 1, 1989–August 31, 1990.** Malhotra, V.M.; Zitter, R.N. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Physics. Mar 1990. 79p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90010589. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The mandate of this project was to understand the mechanism responsible for coal-water interactions and to understand why coal holds water. In addition, we were to develop a bench-scale dewatering technique, based on heavy crude oil (< 20° API) treatments. Consequently, we undertook electron paramagnetic resonance (EPR), in situ desorption kinetics via Fourier transform infrared (ISDK-FTIR), specific heat, and in situ air-drying measurements on Hagel lignite coal, Illinois No. 2 bituminous coal, and oxidized Illinois No. 2 bituminous coal to understand how water interacts with coal. Attempts were also made to dewater Homer City bituminous coal cake and Illinois No. 2 coal-water slurry by treating these coals with (1) n-pentane, (2) petrolene + n-pentane, (3) asphaltene + benzene, (4) crude oil, and (5) crude oil + asphaltene + benzene. 34 refs., 34 figs., 11 tabs.

29972 (DOE/PC/89904–T9) **Studies of the energetics of C-S bond-breaking reactions in radical ions derived from coal model compounds: Final report, January 1, 1989–August 31, 1990.** Bausch, M.J. Southern Illinois Univ., Carbondale, IL (USA). Dept. of Chemistry and Biochemistry. Mar 1990. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-89PC89904. Order Number DE90010590. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This final report contains a summary of our efforts to determine the strengths of C-S bonds in radical anions and radical cations derived from coal model compounds. Most of our efforts have concentrated on determinations of bond dissociation energies (BDEs) in radical ions derived from two isomeric sulfur-containing coal model compounds: 10-phenylthio-9-methylanthracene (1); and 9-phenylthiomethyl-anthracene (2). During the course of this project, we have synthesized gram quantities of (1) and (2), and conducted extensive studies of the strengths of C-S bonds contained in radical cations and radical anions derived from (1) and (2) and diphenylsulfide (3) and benzyl phenyl sulfide (4). BDEs for the weakest C-S bonds in the radical anions derived from 1–4 are 38, 10, 10, and -22 kcal/mol, respectively. BDEs for the weakest C-S bonds in radical cations derived from 2 and 4 are 25 and 5 kcal/mol, respectively. These data suggest that reductive and oxidative chemistries carried out on sulfur-containing coal model compounds do in fact weaken the C-S bonds present in these species. However, under oxidative conditions, it is likely that radical cations such as those derived from 2 and 4 are likely to undergo deprotonation chemistries, thus complicating any analysis of what happens when coal and coal model compounds are oxidized.

29973 (PB–90-167347/XAB) **Undrained shear strength of partially saturated combined coal refuse. First annual report: Strength and consolidation characteristics of coal refuse for design and construction of disposal facilities.** Huang, Y.H.; Li, J. Kentucky Univ., Lexington, KY (USA). Dept. of Civil Engineering. Sep 1986. 93p. Available from NTIS, PC A05/MF A01.

This report summarizes the results of a study on the undrained shear strength of partially saturated combined refuse. The study is part of a research project entitled 'Strength and Consolidation Characteristics of Coal Refuse for Design and Construction of Disposal Facilities supported by the Office of Surface Mining, Department of the Interior. Information presented in the report will be used for the design and construction of disposal facilities. Coal refuse, the waste product from coal washing, is separated in the coal preparation plant into two fractions (coarse and fine). The fine refuse, in the form of either a slurry or a filter cake, is unstable and difficult to handle.

29974 Field evaluation of coal fired utility boiler NO_x and SO_x emissions control by gas reburning - sorbent injection.

Volume 5. Nelson, L.P. (Energy and Environmental Research Corp., Irvine, CA (USA)); Bartok, W.; Folsom, B.A.; Payne, R.; Moyeda, D.; Farthing, G. 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Report 88-86.12.

The authors maintain that proposed legislation to reduce the emission of acid rain precursors would: increase the cost of power due to the addition of air pollution control devices; and increase the use of low sulfur coals, thereby reducing the demand for high and medium sulfur content coals. Consequently, there is a need for a low cost, retrofit acid rain precursor control technology which will provide the electric utility industry with the option to use local coals. This book describes gas reburning-sorbent injection as one such technology.

29975 Transient infrared emission spectroscopy. Jones, R.W. (Center for New Industrial Materials and Ames Laboratory-USDOE, Iowa State University, Ames, IA (US)); McClelland, J.F. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 307.

Transient Infrared Emission Spectroscopy (TIRES) is a new method that produces analytically useful emission spectra from optically thick, solid samples by greatly reducing self-absorption. Self-absorption causes severe truncation of strong bands in the emission spectra of optically thick samples and results in spectra which closely resemble black-body emission spectra, containing little structure characteristic of the material being analyzed. Self-absorption would be reduced if only a thin layer of the material were actually emitting radiation. This is accomplished in TIRES with a laser that is absorbed very near the sample surface, directly heating only a thin surface layer. Emission from the irradiated sample initially has very little self-absorption, but thermal diffusion causes the layer to thicken rapidly, increasing self-absorption. In TIRES only the transient emission immediately following exposure to the laser beam is collected and analyzed. If a continuous laser is used, the sample must move through the beam or the beam must mover over the sample, and only the emission from the beam path directly behind the beam position on the sample is analyzed. If a pulsed laser is used, only the emission immediately after the laser pulse is collected. Results using both types of lasers are presented.

29976 The influence of the mineral matter content of coal on the temperatures and burning rates of char particles during pulverized coal combustion. Mitchell, R.E. (Sandia National Labs., Livermore, CA (USA). Combustion Research Facility). pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Recently (Mitchell, 1988) the authors showed that at comparable residence times in a laminar flow reactor used to provide gaseous environments typical of practical pulverized coal combustors, the temperatures of char particles of nominally the same size can vary considerably. For a narrow range of particle sizes (106 to 125 μm), at any given residence time, the authors observed particles that had temperatures several hundred degrees above the local gas temperature, and particles that had temperatures close to that of the gas. The authors used the equations presented in this paper, to show that at comparable residence times, during the early to relatively late stages of burnoff, the large differences in the temperatures of char particles of the same size can be explained by particle-to-particle variations in ash content. In this paper, the experimental and theoretical procedures are summarized. Variations in the temperatures of char particles at selected residence times are shown for both the uncleaned and cleaned coals. Also shown are overall particle burning rates and apparent chemical reaction rate coefficients calculated from the sizes, temperatures, and velocities of individual particles.

29977 The release of iron during the combustion of Illinois No. 6 coal. Baxter, L.L. (Sandia National Labs., Livermore, CA (USA). Combustion Research Facility); Mitchell, R.E. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

A series of investigations of iron release during the combustion of an Illinois #6 coal are reported. Experimental measurements are described in which 40-70 percent of the iron in the coal is released within a 25 ms period immediately following coal devolatilization. This iron release dominates the evolution of all other inorganic elements in this coal (excluding sulfur) on a mass basis. The release is consistently observed in controlled combustion environments over a particle size range from 75-125 μm and a gas oxygen concentration range of 6-12 percent. Statistical uncertainty of the results is also reported and is small compared to the measured effect. Further experiments and analysis were conducted to determine the mechanism of iron release. Forms of iron with sufficient volatility to explain the results as a vaporization process were investigated. None was found that could reasonably be expected to form under the experimental conditions. Further experimentation suggests that the mechanism is related to the chemical reactivity of the iron species with oxygen and that the release proceeds through the chemical formation of an iron fume.

29978 Factors controlling residual ash particle size distribution. Kang, S.-G. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Chemical Engineering); Charon, O.; Sarofim, A.F.; Beer, J.M. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

The composition and size of residual flyash particles have a major impact on fouling and slagging. This paper presents recent theoretical and experimental developments on the factors that control the size and composition of flyash produced during pulverized coal combustion. Given the initial distribution of the mineral matter in the coal, models are used to distribute the individual particle in pulverized coal and to determine the fate of that mineral matter during combustion. The results generated by the models are compared with each other. The importance of inclusion size and composition, the pulverization process, and the fragmentation during combustion are identified.

29979 FT-IR photoacoustic analysis of coal surface oxidation by UV/irradiation. McClelland, J.F. (Fossil Energy Programs, Ames Laboratory, Ames, IA (US)); Jones, R.; Oh, J.S. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1601.

The conventional FT-IR method for determining the surface oxidation of an aged coal is to measure the growth in the carbonyl band by subtracting a fresh coal spectrum from an aged coal spectrum. This method suffers from the inherent variability in the spectra of fresh coal samples and the relatively deep probe depth of infrared analysis in the carbonyl region of coal spectra. The fresh coal variability problem makes it difficult to compare data from one laboratory to the next whereas the probe depth in the carbonyl region of approximately 10 μm (assuming an absorption coefficient of 100 cm^{-1}) implies that the compositional information obtained is more related to the bulk than the surface. Hence an analytical method is needed for coal surface analysis that does not require a fresh coal standard and that is more surface specific. This paper reports a new FT-IR/UV method for coal surface analysis that gauges the amount of carbonyl-forming species present at a given time in an aged coal sample rather than how much carbonyl has been produced in the progression from a fresh to an aged surface condition.

29980 Air oxidation of bituminous coals and its effect on floatability: Diffuse reflectance infrared Fourier Transform (DRIFT) spectroscopic analysis. . Xiao, L. (Columbia Univ., New

York, NY (USA). School of Mines); Somasundaran, P.; Vasudevan, T.V. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper reports on the examination of the effect of induced air oxidation on the wettability behavior of coal by studying its microflotation response and was correlated to the changes in surface organic moieties. Two different bituminous coals, Upper Freeport (PA) and Illinois No. 6 seams, were examined for their flotation response to treatment by air-heating for 24 and 72 hours at 200 °C. Although there was a sharp decrease in the floatability of coals after 24 hours of heating, no further drop was observed beyond this time interval. Analysis of surface organic groups, by diffuse reflectance Fourier transform (DRIFT) spectroscopy, indicated a complete disappearance of aliphatic CH groups by oxidation to carbonyl groups upon heating in air. However, there was no noticeable effect of heating, even for 72 hours, on aromatic CH and C=C groups. Initial decrease in floatability was attributed to the loss in hydrophobicity contributed by the aliphatic CH groups and the residual floatability to aromatic CH and C=C groups which was not susceptible to oxidation at the temperature (200°C) used.

0108 Waste Management

Refer also to citation(s) 29973, 30286, 30298, 30301, 30302, 30303, 30304, 30305, 30306, 30307, 30308, 30493, 30892

29981 (DOE/FE–0176P) **Coal-Based Gas Stream Cleanup Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 20p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010270. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall goal of the Coal-Based Gas Stream Cleanup Program of the Office of Coal Technology (OCT) is to develop new technologies to control and/or remove gas stream contaminants such as particulates, sulfur compounds, nitrogen compounds, alkalis, selected trace metals, and residual hydrocarbons that are detrimental to the development of coal-fueled power systems, and to develop contaminant control technologies within a timeframe consistent with intended conversion system technology development. Specific program goals are: develop advanced cleanup techniques upstream of the turbine for cost-effective component and environmental protection for PFBC, direct coal-fueled, and gasification turbine combined cycles; review the stage of fuel cells R&D with respect to the cleanup R&D technology available to determine if future critical technology support work is warranted; and review with the diesel program the critical needs for GSCU support and pursue, if warranted, future R&D cleanup support for diesel power systems. 1 fig., 1 tab.

29982 (DOE/FE–0177P) **Waste Management Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 25p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010269. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the Waste Management Program is to help achieve the objective for reducing the national dependence on imported oil through the use of domestic fossil energy resources; in particular, to ensure that coal wastes do not become an impediment to coal use. Unlike process development, for the most part, the Waste Management Program does not have completion timetables, but is rather an ongoing program that supports coal-use technology improvements. Specific objectives of the program are to: promote the development of environmental acceptable waste disposal options; determine that the management of wastes can be accomplished in an efficient and reliable manner commensurate with acceptable economics; ensure that waste issues do not become a roadblock to the economical implementation of advanced coal-use technologies; encourage waste utilization options as alternatives to waste disposal; characterize and identify potential concerns regarding a technology waste so that they can be addressed early in engineering design; and maintain a current awareness of waste management concerns and regulations and provide comments to regulatory agencies on issues that address wastes from coal-use technologies. A technology description and market applications discussion is provided in this report. 1 fig. 3 tabs.

29983 (DOE/FE–0185P) **Flue Gas Cleanup Program: Fiscal year 1990, Summary Program Plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 28p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010265. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Flue Gas Cleanup Program in the Office of Fossil Energy (FE) supports and extends both the long-range R&D requirements associated with environmental control technology and the clean coal technology demonstration activity through emphasis on: a technology base that increases confidence in the Nation's ability to successfully demonstrate and apply new approaches to the clean and affordable use of domestic coal supplies. The development and verification of advanced technologies that offer improved capability, as well as reduced cost, in managing currently regulated pollutants. The exploration and characterization of technologically advanced new concepts and systems approaches that could conceivably be required in the future to control additional pollutants currently identified as major sources of concern. A technology description and market applications discussion is provided in this report. 1 fig., 4 tabs.

29984 (DOE/MC/22118–2818) **Field study of disposed wastes from advanced coal processes: Quarterly technical progress report, November 1989–January 1990.** Radian Corp., Austin, TX (USA). [1990]. 40p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC22118. Order Number DE90010051. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Department of Energy/Morgantown Energy Technology Center (DOE/METC) has initiated research on the disposal of solid wastes from advanced coal processes. The objective of this research is to develop information to be used by private industry and government agencies for planning waste disposal practices associated with advanced coal processes. There has been considerable research on the characteristics and laboratory leaching behavior of coal wastes – a lesser amount on wastes from advanced coal processes. Information on field disposal behavior is needed (a) as input to predictive models being developed, (b) as input to the development of rule of thumb design guidelines for the disposal of these wastes, and (c) as evidence of the behavior of these wastes in the natural environment. The specific objectives for the reporting period of November, 1989 to January, 1990 were as follows: characterize initial waste samples collected at the Colorado-Ute site; collect first quarterly water samples at the Colorado-Ute site; select soil samples from Colorado-Ute for initial characterization; characterize initial samples of waste and soil from the Ohio Edison site; characterize the first quarterly water samples from the Ohio Edison site; and select the fourth site location. Results are discussed. 10 figs., 9 tabs.

29985 (KEMA–88-617) **Waste water treatment of coal gasification systems.** Verdijk, J.W.M. Keuring van Electrotechnische Materialen NV, Arnhem (Netherlands). Jun 1988. 21p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

Coal gasification processes cause considerable quantities of waste water of which treatment needs special attention. First an overview is given of coal gasification techniques (fixed bed, fluid bed, entrained bed) and gasification processes. Then the waste water sources and the components and composition of the waste water fluxes are dealt with. Dependent on the location and the requirements several treatment steps can be distinguished: filtration of solid materials, flocculation of heavy metals, stripping of volatile matter, and oxidation of organic matter. Next for the design of a waste water treatment system two situations are discussed: chloride discharge admitted or not admitted (concentration of the waste water by evaporation). Finally a comparison is made between

waste water from coal gasification and waste water from a ROI-system. 1 tab., 9 apps.

29986 (PB–90-171331/XAB) **Solid-waste codisposal study. Final report, June 1986-December 1987.** Manz, O.E.; Groenewold, G.H. North Dakota Univ., Grand Forks, ND (USA). North Dakota Mining and Mineral Resources Research Inst. Mar 1988. 213p. Available from NTIS, PC A10/MF A02.

Gasification and associated combustion of lignite coal, as occurs at Beulah, North Dakota, results in solid and liquid wastes, some of which may be considered hazardous. Disposal of these wastes is of ongoing concern. Determining the potential to reduce the hazardous nature of certain waste liquids by blending them with other non-hazardous cementitious wastes is the objective of the report. Liquid waste incinerator blowdown (LWIBD) and multi-effect evaporator concentrate (MEEC), two of the liquid wastes produced at the gasification plant, as well as scrubber and bottom ash from the combustion plant, were used in the study. The study tested the leaching characteristics of a matrix of fabricated cylinders made up of various proportions of the three solid wastes plus tap water, MEEC, or LWIBD as the make-up liquid. These cylinders were cured for different times at different temperatures and then were subjected to leaching by the TCLP regulatory method and by a variation of the TCLP method that employed simulated groundwater. Physical tests, as well as comprehensive XRD, SEM, and chemical characterization of the starting materials and the fabricated products were also done. The study showed that codisposal is an effective means of reducing the degree of leaching from wastes.

29987 (PB–90-861808/XAB) **Fly ash: Reutilization and applications in the concrete and cement industry. May 1986-January 1990 (a Bibliography from the COMPENDEX data base). Report for May 1986-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 73p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857684.

This bibliography contains citations concerning the use of fly ash in the concrete and cement industry. Mechanical, physical, and chemical properties of fly ash-containing concretes, aggregates, mortars, and grouts are considered. Applications of these materials to highways, construction, soil stabilization, and building repair are included. (This updated bibliography contains 143 citations, 31 of which are new entries to the previous edition.)

29988 An argon/helium ICP for detection of trace metals is fossil fuel-derived process gas streams. Romanosky, R.R. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center); McCarty, D.L.; Chisholm, W.P. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 074.

On-line, real-time instrumentation is needed for the trace elemental analysis of fossil fuel-derived process streams. Gasification and combustion processes require trace elemental analysis for a variety of reasons, such as assessing the corrosion/erosion potential of the hot, particle-laden gas streams, generating data for validation of process models, and determining the environmental emissions from the process. Typically, standard methods for trace elemental analysis involve the use of impingers and/or filters for the extraction of the sample. The samples are subsequently taken to a laboratory for analysis by atomic absorption/emission instrumentation. These methods are often inaccurate due to sample transfer and handling. They are also manpower and time intensive and generate only time-averaged data, which is not desirable for either process modeling or environmental assessments. Additionally, these methods typically suffer from spectral and molecular interferences, non-linearity, and poor detection limits caused by sample matrix interferences. Topics to be covered include a discussion of the similarities and differences in performance characteristics among argon, argon-helium, and helium plasmas; a description of the ICP instrumentation capable of on-line, real-time analysis; and data obtained from the ICP analyzing gaseous particle-laden process streams from a coal-fired combustor.

29989 Desulfurization using calcium-based sorbents in transport-bed combustor and fluidized-bed gasifier. Schmidt, D.K. (Kellogg (M.W.) Co., Houston, TX (USA)); Sadhukhan, P.; Lin, Y.Y. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper summarizes in-situ desulfurization performance data of two advanced hot gas processes. The transport-bed combustor was demonstrated at Kellogg's atmospheric pressure pilot test facility in Houston while the pressurized fluidized-bed gasifier was demonstrated at Kellogg's KRW pilot plant in Pennsylvania.

29990 Evaluation of soda ash-line sorbents in a spray dryer system for SO_2/No_x control. Markussen, J.M. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center); Pennline, H.W. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper reports on an evaluation of spray dryer injection of soda ash (Na_2CO_3) solutions and soda ash-lime slurries which was conducted in a small-scale spray dryer facility. The test objectives were to observe the removal of both sulfur dioxide (SO_2) and nitrogen oxides (NO_x) under various operating conditions, along with any changes in the nitrogen dioxide (NO_2) concentration. Lime was added to soda ash solutions in varying proportions to determine if NO_2 stack gas concentrations could be minimized with lime reagent while maintaining the NO_x removal obtainable with the soda ash reagent.

29991 Monequilibrium sulfur removal from high temperature gases. Abichandani, J.S. (Morgantown Energy Technology Center, Morgantown, W.V. (US)); Loftus, P.J.; Diehl, R.C.; Woodroffe, J.A.; Holcombe, N.T. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC21-86MC23167;AC21-86MC23262. (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

Thermodynamic limitations on the sulfur capture from combustion gases by calcium-based sorbents can be circumvented under thermal nonequilibrium conditions. Experimental results for sulfur species reaction with calcium at combustion temperatures (1800-2400 K) are discussed. At these temperatures, the expected equilibrium sulfur capture is essentially zero. The progression of the nonequilibrium concept from the bench scale testing to demonstration in a coal-fired gas turbine combustor is described.

29992 Life cycle test of the NOXSO process: Simultaneous removal of NOsub x and SOsub 2 from flue gas. . Hasibeck, J.L. (NOXSO Corp., Library, PA (USA)); Neal, L.G.; Ma, W.T.; Yeh, J.T.; Pennline, H.W.; Solar, J.P. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper summarizes the data generated by the NOXSO Life Cycle Test Unit (LCTU). The paper is divided into the following subsections: description of the NOXSO Process, description of the LCTU, description of the NOXSO sorbents used in the test, SO_2 removal efficiency, NO_x removal efficiency, sorbent regeneration, physical and chemical analyses of sorbent used in the test, and attrition data. In addition, information is provided on work undertaken to develop an improved NOXSO sorbent that is more chemically active and more resistant to physical attrition.

29993 Coal-fueled two-stage slagging combustion island and cleanup system for gas turbine application. Cowell, L.H. (Solar Turbines, Inc., San Diego, CA (USA)); Hasen, A.M.; LeCren, R.T.; Stephenson, M.D. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

In order to reduce reliance on fuels which are either imported or likely to be in short supply in the future, Solar Turbines Incorporated, with the support of the Dept. of Energy's Morgantown Energy Technology Center, is developing a coal-fueled version of one of its gas turbines. This paper describes the system which includes a slagging combustor island and a particulate cleanup device. One of the major historical problems with using coal as a gas turbine fuel has been damage to the turbine section caused by mineral matter in coal. A two-stage combustor, featuring an aerodynamic means of removing some of the mineral matter as molten slag in the primary zone, was selected as a design approach. To increase the slag removal, a particulate removal impact separator is incorporated downstream of the primary zone. In combination with the primary zone this device removes over 90% of the mineral matter in the coal. A secondary ceramic barrier filter is located after the secondary zone and before the turbine section of the gas turbine to remove the resulting particulates and mineral matter not removed as slag. To control sulfur dioxide emissions a calcium-based sorbent is injected in the secondary zone. Control of nitrogen oxide emissions (NO_x) is effected by operating the primary combustion zone fuel-rich to suppress conversion of organic nitrogen and formation of thermal NO_x. A rapid thermal quench and lean secondary zone completes the combustion process.

0109 Environmental Aspects

Refer also to citation(s) 29937, 29955, 29982, 29984, 29992, 29993, 30019, 30494, 31351, 31636

29994 (AD-A-217075/1/XAB) **Compliance testing of the Clear AFS Power Plant, coal-fired boiler 1, Clear AFS, Alaska. Final report, 18-23 April 1989.** Scott, P.T. Air Force Occupational and Environmental Health Lab., Brooks AFB, TX (USA). Oct 1989. 96p. (USAFOEHL-89-112EQ0998KEF). Available from NTIS, PC A05/MF A01.

The 13 MWS/DE through HQ AFSPACECOM/SG requested AFOEHL Quality Function conduct source emission testing of the Clear AFS Power Plant to determine compliance with applicable Alaska Air Quality Control Codes. The Alaska Department of Environmental Conservation required testing of one representative boiler for permit compliance and to determine operating limitations for each boiler. At 80,000 lbs steam/hour particulate emission were within emission limits allowed by the State of Alaska.

29995 (CONF-890814-10) **Greenhouse gas emissions from selected alternative transportation fuels market niches.** Santini, D.J.; DeLuchi, M.A.; Vyas, A.; Walsh, M. Argonne National Lab., IL (USA). [1989]. 37p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-31109-ENG-38. From American Institute of Chemical Engineer's summer national meeting; Philadelphia, PA (USA); 20-23 Aug 1989. Order Number DE90010491. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The incremental worldwide effects on greenhouse gases are estimated for the substitution of natural gas- or methanol-based light-duty vehicles for current gasoline-based vehicles in the United States. The effects are estimated on a per-vehicle mile basis, holding acceleration, passenger capacity, engine technology, and range of the vehicle constant. The relative merits of natural gas- or methanol-based vehicles for commuting and other household vehicle market niches are considered. In terms of net global greenhouse gas emissions, the replacement of crude-oil-derived gasoline by non-gasoline fuels derived from natural gas is superior to the use of gasoline derived from natural gas. The transition paths from oil to natural-gas-based light-duty vehicle fuels is examined, considering the effects of the substitution of currently flared natural gas for crude oil as the raw material for transition transportation fuels. Greenhouse gas emissions arising from the following raw material pathways are compared: oil to gasoline; natural gas to the atmosphere, flared combustion products to the atmosphere, compressed natural gas in vehicles, methanol in vehicles, methyl tert-butyl ether in vehicles, and gasoline in vehicles; and coal to methanol. 33 refs., 6 figs., 2 tabs.

29996 (DOE/MC/26387-2810) **Appalachian coal: The clean fuel choice for today's needs and tomorrow's growth.** Virginia Coal Council, Richlands, VA (USA). [1989]. 216p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG21-90MC26387. (CONF-8910183--: 11. annual conference and exposition on Appalachian coal: the clean fuel choice for today's needs and tomorrow's growth, Roanoke, VA (USA), 2-4 Oct 1989). Order Number DE90000469. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

A conference on Appalachian Coal was held in Roanoke, Virginia. Topics of discussion are presented in this report. Included are discussions on acid rain legislation, coal technologies, US clean coal technology program, and cogeneration. (CBS)

29997 (PB-90-147612/XAB) **Alternative practices for outcrop barriers for the Department of Interior, Office of Surface Mining. Final report.** Dames and Moore, Park Ridge, IL (USA). 22 May 1980. 44p. Available from NTIS, PC A03/MF A01.

The use of natural outcrop barriers in surface mining to prevent slides and erosion has been required by the federal regulatory agencies since the introduction of Public Law 95-87 in August 1977. However, individual states have required and used natural outcrop barriers prior to 1977, although in some states, substitution of artificial barriers for natural barriers has been allowed and has found increasing use, especially in West Virginia. Dames & Moore was, therefore, requested by the U.S. Department of the Interior, Office of Surface Mining, to perform a study of the use of artificial barriers in lieu of natural barriers and to evaluate requirements necessary for the construction of artificial barriers.

29998 (PB-90-153164/XAB) **Surface-mining water-diversion design manual. Technical report.** Anderson, S.A.; Fullerton, W.T.; Li, R.M.; Peterson, M.R.; Schall, J.D. Simons, Li and Associates, Inc., Fort Collins, CO (USA). Sep 1982. 444p. Available from NTIS, PC A19/MF A03.

Also available from Supt. of Docs.

The manual provides basic information and procedures for hydrologic analysis and the design and implementation of an adequate drainage system before, during, and after surface mining operations to minimize adverse environmental impacts. It is a comprehensive design manual for use by experienced engineers and hydrologists.

29999 (PB-90-167339/XAB) **Effects of controlled overburden placement on mine-spoil properties, revegetation, and the growth of Pitch X loblolly pine hybrid seedlings as demonstrated on an abandoned strip bench. Final report.** Daniels, W.L.; Burger, J.; Roberts, J.; Moss, S. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). 15 Aug 1986. 131p. Available from NTIS, PC A07/MF A01.

Surface coal-mine reclamation efforts depend on a knowledge of soil development and nutrient cycling. Gaining an understanding of soil genesis in various parent materials and in different cultural amendments will aid the success of revegetation and reclamation. Studies in soil genesis are needed to determine if rock-mine spoils are suitable as a topsoil substitute. A knowledge of mechanisms of nutrient cycling in these materials will aid the development of management strategies for successful reclamation. The report summarizes findings from Phase II of the Controlled Overburden Placement Experiment, funded by OSM. The data reported pertain primarily to the second and third growing seasons, 1983 and 1984. The experiment is composed of two parts, a rock-mix experiment and a surface-treatment experiment. Second-year results confirm topsoil substitutes can outperform topsoiled plots in these particular mine soils.

30000 (PB-90-167701/XAB) **Hydrology and sedimentology manual. Final report.** Sato, J.F.; Sunday, G.K.; Weagraff, H.M.; Eggert, K.G.; Li, R.M. Sato (J.F.) and Associates, Inc., Littleton, CO (USA). 6 Nov 1989. 528p. Available from NTIS, PC A23/MF A03.

This document presents techniques thought to be most appropriate for analysis of mineland hydrology, hydraulics, geomorphology sedimentation and associated hydraulic structures in the western United States. The volume serves as a reference for the evaluation and review of mine plans, and to provide background for the material included in the accompanying volume Hydrology and sediment yield work manual. However, it is also addressed to the larger problem of acquiring an understanding of the physical processes associated with runoff acting in a surface mining environment.

30001 (PB–90-172529/XAB) **Engineering-scale evaluation of thermal desorption technology for manufactured-gas plant-site soils. Topical report, July 1988-August 1989.** Helsel, R.; Alperin, E.; Groen, A. IT Corp., Knoxville, TN (USA). Nov 1989. 102p. Available from NTIS, PC A06/MF A01.

As part of a program to evaluate and develop technologies for remediation of contaminated soils at manufactured gas plant (MGP) sites, pilot plant tests of a thermal desorption treatment technology were performed. Coal-tar-contaminated soil samples from three MGP sites were characterized, and bench-scale treatability tests were performed to establish treatment conditions to use for the pilot tests. A series of 11 pilot tests were completed using an indirectly heated rotary desorber operating at 30 to 60 kilograms/hour of soil. Treatment conditions of 300 C and 400 C and soil residence times of 5 and 9 minutes were used. Total polycyclic aromatic hydrocarbon concentrations were reduced to between 150 and 1 part per million (ppm) from initial levels of 2000 to 400 ppm, depending on treatment conditions. Temperature, residence time, and soil type all had a significant effect on treatment efficiency. Reasonable agreement was found among results from the static, batch, bench-scale test apparatus and the dynamic, continuous pilot plant.

30002 (PB–90-172552/XAB) **Laboratory study of the effect of thermal treatment on the metal, leaching characteristics of soils from manufactured gas plant sites. Topical report, April 1988-August 1989.** Helsel, R.W.; Groen, A. IT Corp., Knoxville, TN (USA). Nov 1989. 125p. Available from NTIS, PC A06/MF A01.

As part of GRI's program to evaluate and develop technologies which are potentially applicable for remediation of manufactured-gas plant sites, bench-scale tests were performed to show whether thermal treatment of soil to remove organic contaminants would increase the leachability of regulated metals present in the soils. Soil samples from six manufactured gas plant (MGP) sites were characterized and subjected to various temperature and atmosphere conditions in a static laboratory oven. Treated and untreated soil samples were subjected to the EPA standard EP toxicity leaching test as well as an ASTM leaching test using distilled water. Concentrations of regulated metals in the leachates were compared to determine the influence of treatment conditions and soil type on leaching behavior. The study showed that at conditions expected to be required for thermal treatment, metal leaching characteristics were not significantly altered. Based on the soils tested and other MGP soil analyses, Resource Conservation and Recovery Act (RCRA) metals appear to be present at levels which should not result in failure of the EP toxicity test criteria.

30003 (PB–90-173295/XAB) **Effects of surface mining on the stream flow, suspended sediment, and water quality in the Stony Fork drainage basin, Fayette County, Pennsylvania. Final report.** Mastrilli, T.M.; Stump, D.E. Geological Survey, Reston, VA (USA). Water Resources Div. 11 Jun 1989. 34p. Available from NTIS, PC A03/MF A01.

A study of the 7.44-square-mile Stony Fork Basin was made from 1977 through 1980 to determine the impacts of surface coal mining on the quality of water in Stony Fork. Stony Fork was sampled at six sites, during which time surface mining increased in the basin from 0.5 to 5.5%. Stream flow, suspended-sediment, and water-quality data were collected at gaging stations upstream and downstream from mining. The total runoff between the upstream and downstream stations differed by 1% during the investigation, which suggests that streamflow was not noticeably affected by mining. Surface mining increased the suspended-sediment yield during storms due to erosion from mine sites. The suspended-sediment yield doubled at the downstream site following mining. Specific conductance was highly variable during storm runoff but generally varied inversely with flow and increased slightly during the investigation. The remaining chemical properties analyzed showed no consistent increases due to mining. An area that had been underground mined and subsequently surface mined, resulted in the discharge of increased levels of acidity and iron.

30004 (PB–90-173303/XAB) **Effects of surface coal mining on suspended-sediment discharge in a small mountain watershed, Fayette County, Pennsylvania. Water Resources Investigation.** Mastrilli, T.M.; Stump, D.E. Geological Survey, Denver, CO (USA). 1986. 27p. (USGS/WRI–85-4093). Available from NTIS, PC A03/MF A01.

Data collected in the upper Stony Fork Basin from July 1980 to November 1981 indicate that logging operations associated with block-cut surface coal mining temporarily increased the suspended-sediment discharge of Stony Fork. However, the strip-mining operation did not increase the suspended-sediment discharge of Stony Fork because of effective sediment-control measures. These controls include diversion terraces and a large sediment-control pond. The 50-acre mine site yielded an average of 6.9 tons of sediment per acre, whereas the sediment yield of the 2.5-square-mile study area was 0.13 tons per acre. During most storms, sharp increases in streamflow were accompanied by corresponding increases in suspended-sediment concentrations. At the end of a storm, suspended-sediment concentrations quickly returned to base-flow levels. Instantaneous water discharge ranged from 0.02 to 146 cubic feet per second. Average monthly water discharges ranged from 0.30 to 14.3 cubic feet per second. Suspended-sediment concentration ranged from less than 10 to 905 milligrams per liter. The highest daily mean suspended-sediment concentration was 176 milligrams per liter.

30005 (PB–90-177940/XAB) **Improved emission factors for fugitive dust from Western surface-coal-mining sources.** Axetell, K.; Cowherd, C. Environmental Protection Agency, Cincinnati, OH (USA). Jul 1981. 36p. Available from NTIS, PC A03/MF A01.

The purpose of the study was to develop emission factors for significant surface-coal-mining operations that would be applicable at all Western mines and would be based on widely acceptable, state-of-the-art sampling and data analysis procedures. The approach was to develop emission factors for individual mining operations in the form of equations with correction factors to account for site-specific conditions. Factors were determined for three particle size ranges. A total of 265 tests were run at three mines during 1979 and 1980. Several variables that might affect emission rates were monitored during the tests. Significant correction parameters in the emission factor equations were then determined by multiple linear regression analysis. Confidence intervals were also calculated for each of the factors. Data for determination of deposition rates were obtained, but scatter in the data prevented the development of an algorithm. Emission factors from the study are compared with previous factors, and specific limitations to their applicability are stated.

30006 (PB–90-177957/XAB) **Emission factors and control technology for fugitive dust from mining sources (third draft).** Environmental Protection Agency, Cincinnati, OH (USA). Oct 1980. 25p. Available from NTIS, PC A03/MF A01.

The need for accurate emission factors for surface-coal-mining operations has led to the present extensive field sampling study at Western mines. The final emission factors must be capable of estimating emissions from a wide range of mining activities and geographic areas, so the sampling should cover as much of this spectrum as possible. Existing emission factors have generally been found to be inadequate because they are based on only limited sampling or on nonrigorous sampling techniques. The statistical plan is being prepared to estimate the number of additional samples that will be needed to produce emission factors with the desired precision. The approach on which the study has been based is that the final emission factors will be mean emission rates with correction factors attached to adequately account for the wide range of mining and geographic conditions over which the emission factors must be applied.

30007 (PB–90-178856/XAB) **Surface Mining and the Natural Environment: Technical manual-Phase 2.** Beyer, L.E.; Nickel, R.E.; Diaper, J.A. Interstate Mining Compact Commission, Lexington, KY (USA). Mar 1979. 327p. Available from NTIS, PC A15/MF A02.

Surface Mining and the Natural Environment is a multi-media instructional aid examining the process of surface mining, its potential impacts on the natural environment, and reclamation and pollution control techniques used to minimize those impacts. The complete instructional package consists of a technical manual, prerecorded cassette tapes, and color slides and carousel trays.

30008 (PB–90-179763/XAB) **Stream flow and stream quality in the coal-mining region, Patoka River Basin, Southwestern Indiana, 1983-85. Water-resources investigations.** Renn, D.E. Geological Survey, Indianapolis, IN (USA). Water Resources Div. 1989. 75p. (USGS/WRI–88-4150). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The report describes the results of a study by the U.S. Geological Survey to determine the stream flow and stream quality in the Patoka River and its tributaries, including the South Fork Patoka River and its tributaries. The South Fork Patoka River is the largest tributary to the Patoka River. Because the flow in the Patoka River is regulated by Patoka Lake, data collection was designed to represent four different flow conditions in the Patoka River: Dry-weather steady-state low flows with large releases of water from Patoka Lake; dry-weather steady-state high flows with small releases of water from Patoka Lake; wet-weather nonsteady-state high flows with small releases of water from Patoka Lake; and wet-weather nonsteady-state high flows with large releases of water from Patoka Lake. The tributaries were sampled four times at two different flow conditions–twice during dry-weather steady-state low flows and twice during wet-weather nonsteady-state high flows.

30009 (PB–90-180837/XAB) **Suspended-sediment yields from an unmined area and from mined areas before and after reclamation in Pennsylvania, Hune 1978-September 1983. Water-Resources Investigations.** Reed, L.A.; Hainly, R.A. Geological Survey, Harrisburg, PA (USA). Water Resources Div. 1989. 60p. (USGS/WRI–88-4005). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The report describes results of a study to determine sediment yields from areas affected by surface mining in the bituminous coal fields of Pennsylvania, determine sediment yields during different phases of mining, measure the effectiveness of the sediment-control ponds, and compare the sediment yields from areas affected by mining to yields from areas unaffected by mining. Hydrologic data collected by the U.S. Geological Survey from June 1978 through September 1983, from 11 sites in or near the bituminous coal fields of Pennsylvania, were analyzed in the study. Five of the sites were in Tioga County, four were in Clearfield County, and two were in Fayette County.

30010 **Agricultural impacts of coal mine subsidence: Effects on corn yields.** Darmody, R.G. (Univ. of Illinois, Urbana (USA)); Jansen, I.J.; Carmer, S.G.; Steiner, J.S. *Journal of Environmental Quality (USA),* 18(3): 265-267 (Jul-Sep 1989).

This study was conducted to (i) determine the extent of measurable subsidence effects associated with planned subsidence mining, (ii) measure the impact of subsidence on corn (Zea mays L.) yield, and (iii) compare the effects of longwall and high extraction retreat mining methods. Five locations in southern Illinois were included in the 3 yr of the study. A total of 4605 ha in 1985, 6747 ha in 1986, and 7764 ha in 1987 were involved. These areas represented unmined control areas as well as longwall (LW) and high extraction retreat (HER) types of mines. Aerial photographs of the study locations were taken in the spring of each year. Subsided areas were identified, classified, and measured on the photos. The average percent of the study area with measurable subsidence effects was 7.5% for LW mining and 3.3% for HER mining. Corn was harvested each year on selected subsided and nearby unsubsided reference areas. The weighted average reduction in corn yield on land above the mines was calculated by multiplying the affected area by the associated yield reduction. The weighted average yield reduction was 4.7% for LW mining and 1.8% for HER mining. Result for the individual years varied with the weather: the greater the precipitation, the greater the yield reductions. The results also reflect the yearly variation in mining activity, crop sample areas, and overall study areas. In addition, the mitigation of subsidence effects in place at the time of the study also influenced the results, but the potential for mitigation for either mining type was not included in the research.

0110 Reserves, Geology, and Exploration

30011 (LA–11211-Vol.1) **Changuinola peat deposit of northwest Panama: Volume 1, Executive summary.** Cohen, A.D.; Thayer, G.R.; Ramirez, A. Los Alamos National Lab., NM (USA). May 1990. 28p. (In English, Spanish). Sponsored by U.S. Agency for International Development. DOE Contract W-7405-ENG-36. Order Number DE90010078. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results are given for a series of studies designed to access the economic potential of a newly discovered peat deposit located near Changuinola in northwestern Panama. We have focused on using the peat to fuel an electrical power plant for this town, which currently uses high-cost imported oil to generate its electrical power. Analyses of the chemical and physical properties of over 250 samples reveal that the deposit is large (greater than 82 km^2 and averaging 8 m thick), high in purity (greater than 96% organic and less than 0.2% sulfur), and high in heating value (averaging 10,000 Btu/lb dry). In all parameters measured, this peat matches or exceeds in quality peats already fueling power plants in other parts of the world. A preliminary economic assessment reveals that the costs of producing electrical energy in a power plant using Changuinola peat could be competitive with the costs of using either coal or oil. This conclusion was found to be valid regardless of which combination of mining techniques and boiler type was utilized. Furthermore, internal rates of return on investment of between 12.8% and 21% were obtained using a computer code supplied by the Inter-American Development Bank (IDB). These rates exceed the minimum (12%) this bank requires in order to consider such projects for loans. Based on these results, we would strongly recommend that additional funding be sought to conduct prefeasibility studies for building a peat-fired power plant for the town of Changuinola.

30012 (PB–90-173717/XAB) **Handbook for exploration and permit-application review/approval procedures for coal-mining operations under a Federal program. Final report.** Hittman Associates, Inc., Columbia, MD (USA). Feb 1980. 248p. Available from NTIS, PC A11/MF A02.

This handbook provides a description of regulatory procedures governing the process for the review, approval, or denial of permit applications to conduct coal exploration, mining, and reclamation operations under a Federal program for a State. The handbook is intended primarily to familiarize interdisciplinary team members of the Office of Surface Mining with the permit-application review procedures currently being used. It is anticipated that the handbook will also prove useful to other government agency personnel involved in the review process and to industry personnel engaged in the preparation of permit applications.

30013 (PB–90-174152/XAB) **Handbook for exploration and permit-application review/approval procedures for coal-mining operations under a Federal program. Final report, 20 September 1980-27 Februray 1981.** Hittman Associates, Inc., Columbia, MD (USA). 1981. 260p. Available from NTIS, PC A12/MF A02.

Portions of this document are not fully legible.

The handbook provides a description of the regulatory procedures governing the process for the review, approval, or denial of permit applications to conduct coal exploration, mining, and reclamation operations under a Federal program for a State. The handbook is intended primarily to familiarize interdisciplinary team members of the Office of Surface Mining with the permit application review procedures currently being used. It is anticipated that the handbook will also prove useful to other government agency personnel involved in the review process and to industry personnel engaged in the preparation of permit applications.

0120 Mining

Refer also to citation(s) 30036, 31668

30014 (PB–90-176041/XAB) **Theory and application of mining pressure around a longwall face.** Zhenqi, S.; Tieliu, D.; Yang, S.; Xiaohua, W. Institute of Scientific and Technical Information of China, Beijing, BJ (China). 1988. 12p. (ISTIC-TR-C–000208). Available from NTIS, PC A03/MF A01.

The paper presents a new method of monitoring roof movement and mining pressure by using the underground roof dynamic observing method. The relevant theory–the theory of forming and changing of internal and external stress fields–is introduced. Two practical examples are given.

30015 (PB–90-176058/XAB) **Application of long-hole fracture shotfiring in drivage in outburst-prone coal seams. Technical report.** Rui, C. Institute of Scientific and Technical Information of China, Beijing, BJ (China). 1988. 12p. (ISTIC-TR-C–000209). Available from NTIS, PC A03/MF A01.

The paper describes the essence of long-hole fracture shotfiring and its history of test and application in China's coal mines, introduces the technology and parameters, and points out the key problems which should be noticed and solved in operation. Experiments have been carried out to investigate the effect and results of this method in several coal mines. A comprehensive evaluation is given with respect to the method of long-hole fracture shotfiring.

0130 Transport, Handling, and Storage

30016 (CONF-891185–1) **Innovative/alternative transport modes for movement of US coal exports to the Asian Pacific Basin.** Argonne National Lab., IL (USA). [1989]. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989. Order Number DE90010406. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this study is to identify and describe transport innovations and alternatives which may reduce the delivered cost of US steam coals in APB markets. This study emphasizes alternative transportation modes from four US coal-producing regions and mentions blending combinations involving a fifth region: subbituminous coals of the Powder River Basin in Wyoming and Montana, bituminous coals of central Utah and Colorado, bituminous and subbituminous coals of the Four Corners Region (southeastern Utah, southwestern Colorado, northwestern New Mexico, and northeastern Arizona), bituminous and subbituminous coals of Alaska, and bituminous coals of the Illinois Basin (Illinois, Indiana, and western Kentucky). 1 fig., 5 tabs.

30017 (DOE/EIA–0125(89/4Q)) **Coal distribution, January–December 1989.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 26 Apr 1990. 190p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90010623. Available from NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The coal Distribution report provides information on coal production, distribution, and stocks in the United States to a wide audience including Congress, Federal and State agencies, the coal industry, and the general public. This issue presents information for January through December 1989. Coal distribution data are shown (in Tables 1–33) by coal-producing district of origin, consumer use, method of transportation, and State of destination. All data in this report for 1985–1989 are final.

0140 Combustion

Refer also to citation(s) 29945, 29974, 29976, 29977, 29978, 29986, 29989, 29991, 30313, 30646

30018 (CONF-900107–3) **Transport properties in chromium and Fe-Cr alloys exposed to oxygen-sulfur environments.** Park, J.-H.; Natesan, K. Argonne National Lab., IL (USA). Jan 1990. 50p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 4. Berkeley international conference on erosion-corrosion-wear of materials at elevated temperatures; Berkeley, CA (USA); 31 Jan - 2 feb 1990. Order Number DE90010113. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The diffusivities of oxygen and sulfur in thermally grown oxides of pure Cr ad model alloys of Fe-25 wt.% Cr and Fe-25 wt.% Cr-Re (Re = 1 wt.% of Ce or V) have been determined by means of electrical conductivity measurement. For pure Cr_2O_3, electrical conductivity of the oxide decreased owing to doping with a tracer amount of sulfur at temperatures investigated between 700 and 950°C and $PO2 = 10^{-4}$ atm. The measured diffusivity of sulfur in Cr^2O_3 was at least one order of magnitude higher at 900°C and at temperatures <750°C, four orders of magnitude higher than that of oxygen. The activation energy of oxygen is 3.53 eV, whereas the value for sulfur (0.8 eV) is much lower. The solubility of sulfur decreased with an increase temperature, in general, but was almost constant below 800°C. 20 refs., 15 figs., 1 tab.

30019 (DOE/FE–0179P) **Atmospheric Fluidized-Bed Combustion Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 31p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010268. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the Atmospheric Fluidized-Bed Program is to develop the technology by 1993 so that the private sector can demonstrate and commercialize coal-fired AFB systems for the industrial, commercial/institutional, and residential sectors that are capable of economically generating process steam, indirect and direct heating, and on-site electric power as a means of displacing oil and gas in an environmentally acceptable manner. First generation AFB technology is considered commercial for large industrial boiler applications in the range of 20 MWe or 200,000 lbs/hr steam range. Program accomplishments to date have resulted in at least 15 US boiler manufacturers offering AFB units on a commercial basis and the operation and construction of approximately 130 such units. However, only about 45 of these 130 units are designed to burn coal as a primary fuel. Most of the first-of-its-kind units were of empirical design. Research efforts are in earnest in the developed countries to improve the combustion intensity enhancement, calcium utilization, nitrogen oxides reduction, solid waste disposal and utilization. These efforts are spurred by the market pressure in competition with the oil- and gas-fired boilers for operational reliability, environmental acceptability, and economical viability. To resolve the remaining technical issues, broaden the market sector, and expand the use of AFB technology, DOE is pursuing advanced concepts and special applications of AFB technology development. 1 fig. 4 tabs.

30020 (DOE/FE–0181P) **Advanced Combustion Technology Program: Fiscal year 1990, Summary program plan.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of the Deputy Assistant Secretary for Coal Technology. Sep 1989. 23p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010267. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the Advanced Combustion Technology (ACT) Program of the Office of Coal Technology (OCT) is to develop advanced combustor concepts that will permit coal use in many applications now using oil or gas; allow the continued use of coal, through improved environmental performance, in installations presently burning coal; and significantly improve the efficiency of existing and new utility power generating plant, thereby reducing emissions of CO_2. A technology description, technology status and market applications discussion is provided.

30021 (DOE/MC/23167–2812) **Advanced coal-fueled gas turbine systems: Technical progress report, October–December 1989.** Westinghouse Electric Corp., Orlando, FL (USA). Power Generation Projects Div. 12 Feb 1990. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23167. Order Number DE90010052. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Testing in the subscale slagging combustor rig during this quarter was dedicated to coal-water mixture (CWM) evaluations. The immediate objectives were to demonstrate primary zone carbon burnout, NO_x control, and slag rejection, equivalent to the good levels found with pulverized coal (PC). Subsequent CWM testing will address sulfur capture and the other program objectives. With the focus on CWM work during the quarter, new issues arose, also. Some had to do with fuel properties, such as CWM solids loading, CWM stabilizer loading, mixture temperature, and property changes with time. Some had to do with injection. For example, air atomizing nozzles are used with CWM. The temperature and

flowrate of the air feeding these nozzles became issues. Experience showed that their location was a prime parameter. Finally, one had to do with primary zone residence time. The CWM was found to require more time in the primary zone. This was achieved by physically lengthening the zone. Much of the quarter was devoted to finding the combination of these parameters giving the required combustion performance. 10 figs., 4 tabs.

30022 (DOE/METC–90/4096) **Particle impact probe.** Fasching, G.E.; Smith, N.S. USDOE Morgantown Energy Technology Center, WV (USA). May 1990. 22p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000471. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Morgantown Energy Technology Center has been developing an instrumentation system to monitor the dynamic behavior of particles in fluidized beds with minimum disturbance of particle motion. During the first phase of development, a particle impact probe and a supporting electronic system have been designed. This probe and electronic system show capabilities for measuring the x, y, and z components of momentum transferred to the probe head by individual particle impacts and for measuring the x, y, and z components of solids force exerted on the probe head in dense fluidized beds. The prototype probe had an 0.125-in. diameter stainless steel tube base with an 0.125-in. diameter nylon sphere probe head mounted at one end. When impacted by particles, the probe head produced motion in a miniature electrode system mounted within the tube base. The signals produced by the electrode system were calibrated to produce either the components of the momentum vector of the probe head during individual particle impacts or the components of the force exerted on the probe head during multiple, closely spaced particle impacts. Researchers expect to make a miniature probe and increase its sensitivity and accuracy. 7 refs., 15 figs.

30023 (DOE/PC/90279–T17) **Advanced coal-fueled combustor for residential space heating applications: Quarterly technical progress report No. 1, October 1986–January 1987.** Energy and Environmental Research Corp., Irvine, CA (USA). Aug 1987. 3p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90279. Order Number DE90009902. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this program is to develop an integrated combustor/heat exchanger which burns coal either as a slurry or as a dry ultrafine coal and which is suitable for use in a range of residential space heaters. The objective will be accomplished in two phases. During the current, initial phase combustor concepts will be developed, fabricated, and evaluated. Upon successful optimization of the advanced coal-fueled combustor, the project would proceed to a second phase to integrate the combustor into a prototype space heater to be demonstrated. This quarterly report describes the work performed during the period from October 1, 1986 to January 31, 1987. The entire effort has focused on Task 1, combustor design definition. Performance goals are described.

30024 (DOE/PC/90279–T18) **Advanced coal-fueled combustor for residential space heating applications: Quarterly technical progress report No. 2, February 1987–April 1987.** Energy and Environmental Research Corp., Irvine, CA (USA). Aug 1987. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90279. Order Number DE90009903. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this program is to develop an integrated combustor/heat exchanger which burns coal either as a slurry or as a dry ultrafine coal and which is suitable for use in a range or residential space heaters. This quarterly report describes the work performed during the period from February 1, 1987 to April 30, 1987. The entire effort focused on Task 1, combustor design definition, in particular, the combustor design concepts. 3 figs.

30025 (DOE/PC/90279–T19) **Advanced coal-fueled combustor for residential space heating applications: Quarterly technical progress report No. 3, May–July 1987.** Energy and Environmental Research Corp., Irvine, CA (USA). Oct 1987. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86PC90279. Order Number DE90009904. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this program is to develop an integrated combustor/heat exchanger which burns coal either as a slurry or as a dry ultrafine coal and which is suitable for use in a range of residential space heaters. During this reporting period, technical efforts focused on preparation, including modification as necessary, of existing EER coal burners, and conducting experiments that provided comparative information of burner designs for the dry ultrafine coal. Flame stability and flue gas emissions monitoring are discussed. 7 figs., 3 tabs.

30026 (EPRI-GS–6805) **The 20-MW TVA atmospheric fluidized-bed boiler: Final report.** Manaker, A. (Tennessee Valley Authority, Chattanooga, TN (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Tennessee Valley Authority, Chattanooga, TN (USA); Fluidized-Bed Technologies, Inc., Chattanooga, TN (USA). c Apr 1990. 256p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The objective of this project was to develop atmospheric fluidized-bed combustion (AFBC) technology for use in the utility industry. To this end, the TVA 20-MW AFBC pilot plant was constructed and a comprehensive test program developed and implemented to address process performance criteria as well as scale-up issues associated with applying this technology to utilities. This final report summarizes 20,000 h of plant testing and operations over a 5-yr period from June 1982 through October 1987. Plant evaluations focused on the facility test program, equipment shakedown, performance optimization studies, the fuel and sorbent feed system, turndown capabilities, and balance-of-plant systems development for reliability improvements as well as design simplicity. Results of these tests and evaluations indicate that high performance results are achievable, either meeting or exceeding project objectives. Kentucky coal evidenced combustion efficiencies of greater than 97.5%, and western subbituminous coal (Sarpy Creek) displayed efficiencies of 99%. SO_2 emissions were maintained at or below compliance levels throughout the test program, and NO_x emissions remained well below NSPS limits, averaging between 0.2 and 0.3 lb/MBtu. Overall plant availability improved greatly, from an initial 64% to more than 90%.

30027 **L-star pulsed coal combustor for space heating.** Abichandani, J.S. (Avco-Everett Research Lab., Everett, MA (USA)); Chatwani, A.U.; Keane, K.J.; Kotidis, P.A.; Woodroffe, J.A. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper introduces a residential scale coal combustor has been developed based on the L-Star pulsed combustion principle. The optimized configuration leads to a compact-system which combusts greater than 99 percent coal carbon with dry pulverized de-ashed lignite. The system meets or surpasses the performance goals set for the program.

30028 **Cyclone reactor with internal separation and axial recirculation.** Becker, F.E.; Smolensky, L.A. To Dept. of Energy, Washington, DC. USA Patent 4881476/A/. 14 Nov 1989. Filed date 26 Jul 1988. USA Patent Application 7-224, 413. Int. Cl. F23D 1/04. 18p.

This patent describes a cyclone combustor apparatus. It contains a circular partition plate containing a central circular aperture. The partition plate divides the apparatus into a cylindrical precombustor chamber and a combustor chamber. A coal-water slurry is passed axially into the inlet end of the precombustor chamber, and primary air is passed tangentially into the chamber to establish a cyclonic air flow. Combustion products pass through the partition plate aperture and into the combustor chamber. Secondarily air may also be passed tangentially into the combustor chamber adjacent the partition plate to maintain the cyclonic flow. Flue gas is passed axially out of the combustor chamber at the outlet end and ash is withdrawn tangentially from the combustion chamber at the outlet end. A first mixture of flue gas and ash may be tangentially withdrawn from the combuston chamber at the outlet end. A first mixture of flue gas and ash may be tangentially withdrawn from the combustor chamber at the outlet end and recirculated to the axial inlet of the precombustor chamber with the coal-water slurry.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 29959, 30011, 30458, 30491

30029 (PB–90-153594/XAB) **Economic analysis of alternative regulations for mine access roads. Task order No. 3. Final report.** Mathtech, Inc., Princeton, NJ (USA). 15 Dec 1981. 86p. Available from NTIS, PC A05/MF A01.

The report assesses the economic impact of different levels of regulatory control over the construction, maintenance, and reclamation of mine access roads.

30030 (PB–90-153602/XAB) **Economic evaluation of OSM (Office of Surface Mining) agronomic and biological sciences regulations (revegetation). Final report.** Hittman Associates, Inc., Columbia, MD (USA). Oct 1981. 40p. Available from NTIS, PC A03/MF A01.

The report presents an economic evaluation of potential costs and benefits and the potential effects on small business entities associated with implementing rulemaking changes under the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The general approach to assessing the economic impacts of compliance with the proposed rulemaking changes is summarized in the following steps: Analyze those regulations identifying the issues of potential economic impact. These issues are identified by comparing the existing and proposed regulations with pre-OSM State or Federal regulations. Estimate the cost of compliance with the existing set of regulations including all changes that were codified as of February 1, 1981, and the proposed regulations under consideration by the Office of Surface Mining (OSM). Compare the incremental costs (cents/ton and cents/million Btu) for coal produced from the representative mines under the existing and proposed regulations. Compute the regional cost impacts using regional coal production data. Evaluate the benefits resulting from the implementation of the existing and proposed regulations. Benefits are evaluated qualitatively when quantitative values are not available.

30031 (PB–90-178922/XAB) **Analysis of the Newphew/Spore model for determining costs of coal mining in Appalachia. Computer model study. Final report.** Nephew, E.A.; Spore, R.L. International Business Services, Inc., Washington, DC (USA). 6 Jun 1980. 76p. Available from NTIS, PC A05/MF A01.

See also PB–90-148685. Portions of this document are not fully legible.

The purpose of the study was primarily to determine whether a computer program developed to determine the costs of coal surface mining and reclamation in Appalachia was capable of being responsive to the needs of the Office of Surface Mining for projecting the extraction costs of coal in support of the Small Operator Assistance Program. The study analysis validated the model and adapted it to specific small operator needs in terms of user flexibility. It found that the model as originally programmed was subject to a number of limitations and functional constraints. Although a substantial loosening of these constraints was not feasible within the current scope of work, it did establish an approach to reprogram the model to take into account dynamically certain previously static aspects of the model. The approach was implemented in order to made the model more useful and to establish a baseline for future development.

30032 (PB–90-180613/XAB) **Legacy of coal: The coal-company towns of southwestern Pennsylvania.** Mulrooney, M.M. National Park Service, Washington, DC (USA). Historic American Buildings Survey/Historic American Engineering Record. 1989. 174p. Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-11118. Portions of this document are not fully legible.

The study was originally designed to identify the salient physical characteristics of coal company towns in southwestern Pennsylvania, but in the course of investigation, it became apparent that these communities have much more in common than just architecture and planning. As a result, the report addresses a wide range of subjects pertaining to coal towns, such as labor relations, ethnicity, and lifestyle. The information is presented in three parts. Part I includes a brief explanation of the history of industrial housing in the United States and an introduction to American coal towns. Part II contains five chapters of which three provide detailed information on Star Junction, Windber and Colver, respectively. These include histories of the companies and a discussion of each town's planning and development, architecture, ethnicity, and labor relations. Part II also contains a brief summary of the three towns and a discussion of occupational status, mobility and housing. Part III examines regional differences in miners housing in order to establish a geographical context for the Pennsylvania miners dwelling.

0160 Health and Safety

30033 (PB–90-171554/XAB) **Personal miner's carbon monoxide alarm. Information Circular/1989.** Chilton, J.E.; Carpenter, C.R. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 18p. (BUMINES-IC–9233). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs. Library of Congress catalog card No. 89-600201.

Underground miners may be exposed to hazardous quantities of toxic gases, such as carbon monoxide (CO), generated from mine fires or explosions. Every underground miner is required to carry a filter self-rescuer (FSR), which when operated will remove CO from the miner's breathing air. In addition, every underground miner must have a self-contained self-rescuer (SCSR) near the worksite that will supply breathing oxygen. In many situations, miners do not know when to do either rescuer since they do not know if there is a fire in the mine nor do they carry instrumentation necessary for the detection of the toxic, colorless, and odorless fire product CO. If each miner carried a personal CO alarm, which would respond to high concentrations of CO, the miner would then be alerted when to do either the FSR or SCSR and exit the mine. A prototype personal miner's CO alarm called PEMCOAL unit is small enough to be carried on a miner's belt, has a flash lamp visual alarm, requires no calibration for use, and uses a chemical sensor that changes color by reaction with trace quantities of CO. The chemical sensor was tested at concentrations of CO from 10 to 1,000 ppm, at temperatures from 5 to 40 C, and with several potential mine gas interferents. The PEMCOAL alarm times were sufficiently fast to warn miners before they are exposed to hazardous quantities of CO.

30034 (PB–90-176025/XAB) **Relations between mine ventilation conditions and gas-emission quantities carried by airflow. Technical report.** Ye, R. Institute of Scientific and Technical Information of China, Beijing, BJ (China). 1988. 16p. (ISTIC-TR-C–000211). Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

A common phenomenon frequently encountered in mine ventilation routine practices is that changes of mine ventilation conditions, i.e., changes of air pressure and air quantity, causes sequential variations of gas-emission quantity carried by underground airflow. The relations of these variations form an important part of the mixing kinetics of mine air and gas developed in recent years. These problems are discussed in detail in the paper.

30035 (PB–90-178997/XAB) **Seismic-wave generation and propagation from coal-mine blasts at the Wright Mine, Warrick County, Indiana. Final report.** Braile, L.W.; Sexton, J.L.; Martindale, K.W.; Chiang, C.S. Purdue Univ., Lafayette, IN (USA). 1 Mar 1982. 350p. Available from NTIS, PC A15/MF A02.

The objectives of study of seismic wave generation and propagation surrounding the Wright Mine blasts were: document the level of ground vibration surrounding the Wright Mine including frequency content, duration, peak acceleration, velocity and displacement; relate ground-motion measurements to shot size, local geologic conditions (particularly individual site responses), and possible variations in ground-vibration measurements for different directions from the blasts; relate the levels of ground-vibration observations to standards of perception and damage based on United States Bureau of Mines studies. It should be noted that no observations of possible damage nor perception were made and no seismograph recordings or other observations were made within structures surrounding the Wright Mine. The authors objective was strictly to document the ground vibration characteristics caused by Wright Mine blasts.

30036 (PB–90-179284/XAB) **Health-hazard evaluation report MHETA 89-009-1990, Consolidation Coal Company, Humphrey No. 7 Mine, Pentress, West Virginia.** Kullman, G.J. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 12p. (MHETA–89-009-1990). Available from NTIS, PC A03/MF A01.

An evaluation was made of worker exposure to hydraulic fluid used on the longwall-mining operations at Consolidated Coal Company's Humphrey Number 7 Mine, Pentress, West Virginia. Employees were complaining of headache, eye and throat irritation, congestion, and cough. A particular emulsion oil, Solcenic-3A, was used with water in the mine's hydraulic roof-support system. An analysis of the oil indicated the presence of methyl-isobutyl-carbinol (MIBC), dipropylene glycol, and paraffin hydrocarbons. Personal breathing-zone samples for MIBC were collected from all workers on the longwall mining operation during the two days of the visit. All the analysis indicated concentrations of MIBC below the limit of quantification, which was 0.6 parts per million for an 8 hour sample. These levels were well below the exposure recommendations of the Mine Safety and Health Administration. Exposure to MIBC may be occurring through skin contact with oil through hydraulic line leaks, accidents, and maintenance activity on the hydraulic machines. The report concludes that Solcenic-3A oil constituents in air did not pose a health hazard at the time of the survey.

0170 Legislation and Regulations

Refer also to citation(s) 30012, 30013, 30029

30037 (PB–90-178070/XAB) **Proposed revisions to alternative regulations, Virginia Permanent Regulatory Program. Final report.** STS-D'Appolonia Ltd., Monroeville, PA (USA). Aug 1981. 94p. Available from NTIS, PC A05/MF A01.

On March 3, 1980, the Commonwealth of Virginia submitted to the United States Department of Interior, Office of Surface Mining Reclamation and Enforcement (OSM) a proposed permanent Regulatory Program for Surface Coal Mining and Reclamation Operations. Since the program's submittal, the Virginia Department of Conservation and Economic Development has worked closely with the OSM and the public to refine the program to assure that it is consistent with the requirements of the Surface Mining Control and Reclamation Act of 1988 (P.L. 95-87) and to take into consideration the unique terrain, climate, ecology, and other chemical and physical conditions existing in the coal fields of Virginia. The document proposes revision to the alternative regulations and responds to the Secretary's findings and to other public comments received on the proposed alternatives since the submittal of the permanent program.

02 PETROLEUM

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 30047, 30052

30038 (DOE/BC/14403–T2) **Memorandum of Understanding between the United States Department of Energy and the State of Texas: Annex 1, Characterization of oil and gas reservoir heterogeneity: Fourth quarterly report, January 15, 1990–April 15, 1990.** Texas Office of the Governor, Austin, TX (USA). [1990]. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14403. Order Number DE90009998. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Progress in the fourth quarter of research funded under the auspices of MOU Annex 1 is summarized with respect to seven main subtask areas. These subtask areas are (1) definition of the distribution of carbonate sandbar facies for Grayburg reservoirs; (2) definition of three-dimensional geometry of carbonate sand bodies; (3) analysis of engineering and petrophysical attributes of reservoir flow units; (4) development and testing of extended conventional oil recovery strategies; (5) characterization of gas reservoirs; (6) geologic and engineering characterization of generic gas reservoir types; and (7) refinement of exploitation strategies. Key areas of progress for the third quarter concern subtask 3 and 6. 4 refs., 1 fig.

30039 (PUC-DF-NC–04/81) **Old and new versions of the alpha radiation theory of petroleum origin.** Paschoa, A.S. Pontificia Univ. Catolica do Rio de Janeiro, RJ (Brazil). Dept. de Fisica. Mar 1981. 14p. Order Number DE90626003. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some aspects of petroleum formation and the world distribution of fossil fuels deposits were recent clarified. However, the source of energy associated with petroleum genesis is still largely debatable. Evidence accumulated over the years allows to demonstrate the energetic feasibility of a modern version of the old alpha radiation theory of petroleum origin. This theory is reviewed and examined critically under new light to be reformulated by taking advantage of relevant interdisciplinary data mostly not available when the old alpha radiation theory was suggested, developed and then discredited. The geological ages accepted for the formation of most of the known petroleum reserves are within a range that makes long-lived natural alpha emitters a feasible energy source for at least part of the energy necessary for the formation of petroleum hydrocarbon. (author).

30040 (SAND–90-0013) **Strength analyses of Weeks Island bulkheads.** Blanford, M.L.; Segalman, D.J.; Parrish, R.L. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 48p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90010167. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

When the Morton Salt Mine in Weeks Island, Louisiana was converted into a strategic Petroleum Reserve oil reservoir, massive concrete bulkheads were installed to seal the access shafts against oil or water leakage. Recent inspection of these bulkheads has raised questions about their ability to perform satisfactorily in the event of a catastrophic water leak into the mine. Calculations are reported here which examine the response of the five bulkheads to a worst-case scenario of flooding by brine from the surface into the oil reservoir below the bulkheads. These calculations show that, under conservative analysis assumptions, factors of safety under such a load for the bulkheads sealing the service shaft and the two raisebores are close to 1. The Markel incline and production shaft bulkheads exhibit safety factors in excess of 2 and 3, respectively. 10 refs., 24 figs., 3 tabs.

30041 **Obsidian hydration dating: Field, laboratory, and modeling results.** . McGrail, B.P. (Pacific Northwest Lab., Richland, WA (US)); Pederson, L.R.; Strachan, D.M.; Ewing, R.C.; Cordell, L.S. pp. 421 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

Hydration rind thicknesses found on obsidian artifacts provide one means of estimating the age of an archaeological site. The model used in the method usually assumes a diffusion-controlled reaction of the glass with water. However, results using this model are not always in agreement with other dating methods. Observations of secondary mineral formation on glasses in contact with water vapor suggests that other rate-controlling mechanisms may be operative. In this paper, the authors apply the glass dissolution code GLASSOL, coupled with the geochemical code PHREEQE to model the reaction of Glass Mountain obsidian in water. The results show the importance of accounting for the effects of solution chemistry on the time-dependence of the hydration reaction.

30042 **BASINMAT - fortran program calculates oil and gas generation using a distribution of discrete activation energies.** Sweeney, J.J. (Lawrence Livermore National Lab., CA (USA)). *Geobyte (USA)*, 5(2): 37-43 (Apr 1990).

BASINMAT is a program, written in Fortran 77, that calculates the extent of reaction of a chemical transformation at the geologic time scale with time interval steps of one million years. This program makes it easy to calculate the extent of conversion of kerogen to oil and gas or the evolution of thermal markers once the appropriate thermal history and activation energy distributions are known. The program simulates the chemical reactions in Rock

Eval pyrolysis and calculates the value of T_{max} corresponding to the thermal history and source rock kinetic parameters used. It can also be used to calculate vitrinite reflectance by several methods, calibrate thermal histories or compare the results with other methods of calculating thermal maturation. The program uses parallel Arrhenius-type first order rate expressions integrated over an arbitrary thermal history for a distribution of activation energies. Output is an ASCII file that can be imported to a spreadsheet for later analysis. The author has used this program to make calculations of oil and gas generation in sedimentary basins and to calculate profiles of vitrinite reflectance and T_{max} with depth for a given thermal history. The program can be used in any kinetics application that incorporates a distribution of activation energies, including the case of a distribution with a single activation energy.

30043 Microcomputer control of triaxial rock compaction and creep tests--. Hardikar, M.A. (Texas Univ., Austin, TX (USA). Dept. of Electrical Engineering); Fahrenthold, E.P.; Gray, K.E. *In Situ (USA)*, 13(4): 275-294 (1989).

The introduction of general purpose microcomputers and data acquisition and control peripherals into most engineering laboratories has reduced the need to procure specialized hardware and software for the automation of standard mechanical rock property tests. Nonetheless the development of control software for such applications requires special attention to programming methodology and program structure, in the interest of developing portable and general purpose controllers. The latter objectives are generally not well served by either: FORTRAN coding under DOS, the most common methodology, or low level coding under specialized operating systems, most often employed where response time constraints are severe. This paper discusses how the C language and UNIX operating system provide a favorable environment for the development of a single bang-bang controller for all standard rock compaction and creep tests, minimizing and isolating hardware dependent code development.

0203 Drilling and Production

Refer also to citation(s) 30090

30044 (BNL--43788) **Effects of selected thermophilic microorganisms on crude oils at elevated temperatures and pressures: 1989 Annual report.** Premuzic, E.T.; Lin, M.S. Brookhaven National Lab., Upton, NY (USA). May 1990. 43p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-76CH00016. Order Number DE90000233. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the past several years, a considerable amount of work has been carried out showing that microbially enhanced oil recovery (MEOR) is promising and the resulting biotechnology may be deliverable. We are carrying out systematic studies dealing with the effects of thermophilic bacteria on the chemical and physical properties of selected types of crude oils at elevated temperatures and pressures comparable to those of reservoir conditions. Current studies indicate that during the biotreatment several properties of crude oils are affected. The oils are (1) emulsified, (2) acidified, (3) there is a qualitative and quantitative change in light and heavy fractions of the crudes, (4) there are chemical changes in fractions containing sulfur compounds, and (5) the qualitative and quantitative chemical and physical changes appear to be microbial species dependent. In order to analyze for these changes in the crudes, several instruments have been purchased and dedicated to this program. The results generated in the past fiscal year describing (1)--(5) are presented and discussed in this report. 18 refs., 18 figs., 3 tabs.

30045 (DOE/BC--89/3) **Contracts for field projects and supporting research on enhanced oil recovery: Progress review No. 59, quarter ending June 30, 1989.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Oil, Gas and Shale Technology; USDOE Bartlesville Project Office, OK (USA). May 1990. 109p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000206. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report contains information on contracts for field projects and supporting research on enhanced oil recovery. Brief descriptions of research programs are included. (CBS)

30046 (DOE/BC--90/3/SP) **Bartlesville Project Office FY 1989 annual report.** USDOE Bartlesville Project Office, OK (USA). Apr 1990. 40p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90000220. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Bartlesville Project Office (BPO) was established in 1983 to succeed the Bartlesville Energy Technology Center (BETC). Its lead mission from the Office of Fossil Energy (FE) of the US Department of Energy is to plan and implement research in the Enhanced Oil Recovery (EOR) and Advanced Extraction and Process Technology (AEPT) subprograms of the Petroleum Program. As such, BPO oversees more than 140 research projects falling within these two broad subprograms and support activities. These projects form the major portion of the DOE's National Petroleum Research Program, the critical aim of which is to arrest the decline of domestic oil production and to maximize economic recovery. Project achievements, descriptions and goals are described. 8 figs., 2 tabs.

30047 (DOE/BC/14000--2) **Producing unrecovered mobile oil: Evaluation of potential economically recoverable reserves in Texas, Oklahoma, and New Mexico.** ICF Resources, Inc., Fairfax, VA (USA); Texas Univ., Austin, TX (USA). Bureau of Economic Geology. May 1990. 164p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-86BC14000. Order Number DE90000232. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report is part of a coordinated series of research efforts designed to prepare preliminary evaluations of important components of the domestic unrecovered oil resource. The specific resource of interest is the oil that is displaceable by water and remains in the Nation's reservoir after conventional production. Integrated geologic, engineering, and economic evaluations in this series estimate future reserve additions from this unrecovered mobile oil (UMO) resource under various circumstances. The individual studies consider the effects of change in oil prices and advances in production technology on the economic recovery potential of the UMO resource. Several recovery technologies are evaluated, including the use of waterflooding in conjunction with infill drilling to displace and produce UMO at decreased well spacings. The overall analysis series was conducted in two separate, but coordinated, parts; one at a detailed reservoir level and one at a generalized regional level. At the reservoir level, detailed analyses of three individual Texas reservoirs fully delineated the resource and the potential for UMO recovery in these reservoirs under a variety of development situations. Results of the individual reservoir evaluations were extrapolated to groups of reservoirs with common depositional histories, collectively known as "plays." At the regional level, reservoirs in three major oil producing states, Texas, Oklahoma, and New Mexico, were analyzed to determine the resource volume, potential recovery, and cost and benefits both in the individual states and for the region as a whole. This analysis relied on geologic classification of individual reservoirs, specific rock and fluid properties, and production and development histories to quantify the resource and assess its potential for future UMO recovery. 15 refs., 26 figs., 13 tabs.

30048 (DOE/BC/14126--21) **A semianalytical thermal model for linear steam drive.** Gajdica, R.J.; Brigham, W.E.; Aziz, K. Stanford Univ., CA (USA). Petroleum Research Inst. May 1990. 164p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87BC14126. (SUPRI-TR--75). Order Number DE90000237. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Thermal recovery by steam injection has proven to be an effective means of recovering heavy oil. Forecasts of reservoir response to the application of steam are necessary before starting a steam drive project. A semianalytical model (SAM) has been developed for one-dimensional linear systems and two-dimensional linear cross-sectional systems. Wells are located at both ends of the reservoir. At the injection well, wet steam is injected at a constant rate and enthalpy. The production well produces at a constant flowing bottomhole pressure. The SAM includes formation dip, compressible formation, water, and oil, and thermal expansion of the formation,water, and oil. The model automatically calculates the

steam zone steam saturation and includes the water front and overburden heat losses. The two-dimensional model also includes gravity override of steam. The system of equations is solved by iterating on the injection well pressure. For each iteration, the lengths of the steam, water, and oil zones are determined. The pressure drop is calculated for each of these zones and at each well to compute the production well pressure. This value is compared to the production well boundary condition, and iteration continues until convergence is achieved, usually in five iterations. In the process, front locations, temperatures, pressures, and phase saturations are determined for each of the zones. Since the temperatures and pressures are computed, the compressibility and thermal expansion of the rock, oil, and water can be considered. Oil and water production rates are calculated by material balance. In the two-dimensional model, a new empirical method is presented which determines the shape of the steam front, and an extension of an existing water flooding correlation is used to determine the volumetric sweep efficiency for the reservoir. 56 refs., 72 figs., 15 tabs.

30049 (DOE/BC/14246–3) **Microbial field pilot study: Quarterly progress report, July 1, 1989–September 30, 1989.** Knapp, R.M.; McInerney, M.J.; Menzie, D.E.; Chisholm, J.L. Oklahoma Univ., Norman, OK (USA). School of Petroleum and Geological Engineering. 1 May 1990. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14246. Order Number DE90010104. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this project is to perform a microbially enhanced oil recovery field pilot test in the Southeast Vassar Vertz Sand Unit (SEVVSU) in Payne County, Oklahoma. Indigenous, anaerobic, nitrate-reducing bacteria will be stimulated to selectively plug flow paths which have been preferentially swept by a prior waterflood. This will force future flood water to invade bypassed regions of the reservoir and increase sweep efficiency. Progress is reported on growth/activity in porous media; coreflooding; and microbial modeling. 3 refs., 5 figs.

30050 (DOE/BC/14246–4) **Microbial field pilot study: Quarterly technical progress report, October 1–December 31, 1989.** Knapp, R.M.; McInerney, M.J.; Menzie, D.E.; Chisholm, J.L. Oklahoma Univ., Norman, OK (USA). 2 May 1990. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14246. Order Number DE90010105. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this project is to perform a microbially enhanced oil recovery field pilot test in the Southeast Vassar Vertz Sand Unit (SEVVSU) in Payne County, Oklahoma. Indigenous, anaerobic, nitrate-reducing bacteria will be stimulated to selectively plug flow paths which have been preferentially swept by a prior waterflood. This will force future flood water to invade bypassed regions of the reservoir and increase sweep efficiency. Results are reported on the isolation/characterization of anaerobic bacteria; bacterial mobility and the importance of chemotaxis; careflood experiments; microbial modeling; and surface facilities design. 7 figs., 1 tab.

30051 (DOE/BC/14445–1) **Microbial enhanced oil recovery research: Quarterly report, October–December 1989.** Sharma, M.M.; Georgiou, G. Texas Univ., Austin, TX (USA). Dept. of Petroleum Engineering. Mar 1990. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14445. Order Number DE90010133. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In the previous quarterly report we described the criteria for selecting a microorganism for Microbial Enhanced Oil Recovery studies. After careful consideration we chose Bacillus licheniformis JF-2 because of its ability to withstand reservoir conditions and the production of a surface active lipopeptide. Detailed experiments were conducted in stirred tank fermenters equipped with pH control and constant sparging of air or, in the case of anaerobic experiments, O_2-free nitrogen. The effect of temperature and pH on biomass production, glucose consumption and interfacial tension against decane were determined for both aerobic and anaerobic conditions. 5 figs., 2 tabs.

30052 (DOE/ER/12018–T2) **Scientific drilling and hydrocarbon resources.** National Academy of Sciences - National Research Council, Washington, DC (USA). Board on Mineral Resources. [1988]. 99p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. Order Number DE90010443. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Over the past several years the Geosciences Program of the Department of Energy's Office of Basic Energy Sciences (OBES) has been placing increased emphasis on basic geosciences studies relating to hydrocarbon resources. In 1987, the Department of Energy asked the National Research Council (NRC) to appoint a committee to review scientific drilling options to contribute to a better understanding of the scientific foundations that underlie hydrocarbon technologies. The committee was asked to address the topics of continental drilling efforts, the criteria to be used in the selection of drilling sites and projects and the key scientific issues likely to be illuminated. In considering its charge, the committee focused on research involving, first, scientific drilling to benefit national hydrocarbon energy priorities; second, areas of hydrocarbon research not being undertaken by industry; and third, how scientific drilling could contribute to such research. The committee also considered criteria for selecting drilling sites and projects, and has suggested sites, or classes of sites, as appropriate. This report discusses the accomplishments and recommendations of the committee. 9 refs., 2 figs, 3 tabs.

30053 (NIPER–471) **National Institute for Petroleum and Energy Research monthly progress report for March 1990.** National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). 26 Apr 1990. 47p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90010033. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Monthly Progress Report for March 1990, NIPER-471, is submitted in accordance with the provisions of Cooperative Agreement FC22-83FE60149 between the Department of Energy and the IIT Research Institute. Various programs in enhanced recovery of petroleum and reservoir characterization of fields in Wyoming are briefly discussed. Topics include mobility control, sweep efficiency, heterogeneity, thermal processes, and microbial EOR. (CBS)

30054 Use of inhibitors for scale control in brine-producing gas and oil wells. Rogers, L.A. (Gas Research Inst., Chicago, IL (USA)); Varughese, K.; Prestwich, S.M.; Waggett, G.G. *SPE (Society of Petroleum Engineers) Production Engineering (USA),* 5: 77-82 (Feb 1990).

Field and laboratory work showed that calcium carbonate ($CaCO_3$) scale formation in waters produced with natural gas and oil can be prevented by injection of phosphonate inhibitor into the formation, even if the formation is sandstone without calcite binding material. After the inhibitor squeeze in coproduction field tests, inhibitor squeezes have been successfully used to prevent scaling. Laboratory work has been conducted to determine what types of oilfield waters are subject to scaling. This research has led to the development of a saturation index and accompanying nomographs that allow prediction of when scale will develop into a problem in brine production. Core samples from both fields were used in laboratory studies. Analytical methods to analyze inhibitors in brine a low levels were extended. A complete history of field development and the laboratory backup experiments is included in this paper.

0204 Processing

Refer also to citation(s) 29949, 29958, 29959

30055 (TU/CEA–90-00183) **Phase splitting in complex hydrocarbon systems.** Shaw, J.M. (Toronto Univ., Toronto, ON (Canada)). Toronto Univ., ON (Canada). Dept. of Chemical Engineering and Applied Chemistry. 31 May 1989. 40p. (MICROLOG–90-00183). Available from PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20-C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Significant fluctuation in the light oil yield obtained from laboratory and pilot scale models of heavy oil upgrading, coal/oil coprocessing and direct coal liquefaction processes, arising from

apparently minor perturbations in operating conditions, are frequently attributed to synergism. In this study, some aspects of observed synergistic behaviour are explained in terms of relevant liquid-liquid equilibria. Partial phase diagrams for simple and complex hydrocarbon mixtures including model diluent/solvent mixtures, such as pyrene/naphthalene/tetralin, and bitumen/heavy oil/anthracene oil mixtures are presented. These liquid mixtures are shown to be subject to phase splitting at elevated temperatures. The transition from vapour/liquid to vapour/liquid/liquid occurs at 675 to 700 ° K. A second transition, to a two phase expanded fluid mixture, was observed at hydrogen/methane overpressures in excess of 15 megapascals, in some cases. As the projected or actual operating conditions for hydrogenation processes and the temperature and pressure region over which the mixtures can experience phase splitting overlap, previously-reported synergism is related to phase splitting and compounding factors such as catalyst wetting, localized reagent depletion, and model diluent/solvent selection. 21 Ref.s, 7 figs., 7 tabs.

0205 Products and By-Products

Refer also to citation(s) 30853

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30047, 30491

30056 (DOE/EIA–0109(90/02)) **Petroleum Supply Monthly, February 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 27 Apr 1990. 147p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90009750. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

Data presented in this report describe the supply and disposition of petroleum products in the United States and major U.S. geographic regions. The data series describe production, imports and exports, inter-Petroleum Administration for Defense (PAD) District movements, and inventories by the primary suppliers of petroleum products in the United States (50 States and the District of Columbia). The reporting universe includes those petroleum sectors in "Primary Supply." Included are: petroleum refiners, motor gasoline blenders, operators of natural gas processing plants and fractionators, inter-PAD transporters, importers, and major inventory holders of petroleum products and crude oil. When aggregated, the data reported by these sectors approximately represent the consumption of petroleum products in the United States.

30057 (DOE/EIA–0380(90/01)) **Petroleum marketing monthly, January 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 23 Apr 1990. 189p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90010501. Available from NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.

The Petroleum Marketing Monthly (PPM) is designed to give information and statistical data about a variety of crude oils and refined petroleum products. The publication provides statistics on crude oil costs and refined petroleum products sales for use by industry, government, private sector analysts, educational institutions, and consumers. Data on crude oil include the domestic first purchase price, the f.o.b. and landed cost of imported crude oil, and the refiners' acquisition cost of crude oil. Sales data for motor gasoline, distillates, residuals, aviation fuels, kerosene, and propane are presented. 12 figs., 49 tabs.

30058 (DOE/EIA–0520(90/04)) **International petroleum statistics report, April 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 30 Apr 1990. 36p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010119. Available from NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.

This report presents data on international oil production, consumption, imports, exports, and stocks. The report has three sections. Section 1 contains time series on world oil production, and on oil consumption and stocks in the Organization for Economic Cooperation and Development (OECD). This section contains annual data beginning in 1973, and monthly data for the most recent two years. Section 2 presents an oil supply/consumption balance for the market economies (i.e. non-communist countries). This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. This section contains annual data beginning in 1982, and quarterly data for the most recent two years. 23 tabs.

30059 (NSAEC–90-02273) **Cost of fuel and utilities: Newfoundland and Labrador, 1989.** Newfoundland Statistics Agency Executive Council, NF (Canada). Sep 1989. 78p. (MICROLOG–90-02273). Available from PC Newfoundland Statistics Agency, Executive Council, P.O. Box 8700, St John's, NF, CAN A1B 4J6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This survey of fuel and utility consumer prices was conducted from May 29-June 2, 1989. Retail prices in a number of Newfoundland communities were collected for furnace oil and stove oil, regular leaded and regular unleaded gasoline, diesel fuel oil and electricity. The survey also compares petroleum product prices and electricity rates throughout the province for May 1989 with those in May 1988. The historical supplement shows how prices have moved since the survey started in 1975. Also included are price comparisons of some fuels in the major cities in Canada. The results of this year's survey indicate the average prices of most petroleum products have increased. Furnace oil, stove oil, regular leaded, and regular unleaded gasoline showed slight increases over the past year at 0.6%, 2.0%, 4.0% and 2.1% respectively. The price of diesel fuel oil decreased by 3.6% over the same period. 5 figs., 38 tabs.

30060 (PMA–90-02257) **Canadian petroleum industry: 1989 monitoring report: First six months.** Petroleum Monitoring Agency, Ottawa, ON (Canada). 1989. 101p. (MICROLOG–90-02257). Available from PC Petroleum Monitoring Agency, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report describes the financial performance of the oil and gas industry in Canada during the first 6 months of 1989. The report is based on data from 127 companies accounting for 90% of total revenues of the petroleum industry. The report lists noteworthy happenings in the industry, gives highlights of the 6-month period, then details financial performance, sources and uses of funds, comparative performance with other industries, international flows of funds compared to the previous year, capital structures compared to the previous year, and gives income tax-related data for the current and previous years. Overall industry cash flow rose 4% as a result of the partial recovery of crude oil prices from 1988 levels. In addition, cash flow improvements reflected higher sales volumes of marketable natural gas, more than offsetting lower prices. 12 figs., 19 tabs.

0208 Waste Management

Refer also to citation(s) 30301

30061 (PB–90-166562/XAB) **Proposed amendment to best demonstrated available technology (BDAT) background document for wastes from the petroleum refining industry K048, K049, K050, K051, K052. Volume 18.** Berlow, J.R.; Vorbach, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 151p. (EPA–530/SW-90/012R). Available from NTIS, PC A08/MF A01.

See also Volume 17, PB–90-166554, Volume 19, PB–90-166588 and PB89-142376. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This amendment presents the K048 and K051 solvent extraction data used to develop the proposed treatment standards for non-waste waters; presents the K048 incinerator scrubber water data used to develop the proposed treatment standards for waste waters; and provides EPA's rationale and technical support for

developing proposed revised treatment standards for regulated organic constituents and adding treatment standards for xylene and naphthalene in K048-K052 nonwaste waters and for selecting cyanide as a proposed regulated constituent in wastewater forms of K048-K052. The document amends sections in the Final BDAT Background Document for K048-K052 by presenting additional waste characterization data, treatment performance data, accuracy-corrected data, selection of cyanide as a proposed regulated constituent in K048-K052 waste waters, and calculation of proposed treatment standards, respectively.

0209 Environmental Aspects

Refer also to citation(s) 30071, 30462, 30494, 31351, 31476

30062 (EC/CWS–TR68) **Nestucca oil spill: impact assessment on avian populations and habitat: Technical report series (Canadian Wildlife Service), no. 68.** Rodway, M.S.; Lemon, M.J.F.; Savard, J.-P.L.; McKelvey, R. Environment Canada, Delta, BC (Canada). Canadian Wildlife Service, Pacific and Yukon Region. 1989. 53p. (MICROLOG–90-02385). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

According to U.S. authorities, the Nestucca barge was damaged and began leaking oil off Grays Harbour, Washington on December 23, 1988. The barge was towed offshore, still leaking oil, to the edge of the continental shelf. Oil travelled northward and was first recorded on the British Columbia coast on December 31, 1988. As part of the impact assessment of the Nestucca oil spill in British Columbia, oiled bird mortality was quantified and analysed, surveillance was maintained for the presence of oil on seabird breeding colony sites and known wintering and migration areas, and critical habitat in proximity to oiled areas for wintering waterbird concentrations were surveyed. In the course of those surveys, conducted between January 8 and February 3, 1988, records were kept of oil in other areas. Thirty-one species were identified in a sample of 856 dead birds analysed, with common murres and Cassin's auklets most affected. Oil was encountered on seabird breeding colony islands from Seabird Rocks, south of Barkley Sound on the west coast of Vancouver Island, to as far north as the Moore Islands, north of Bella Bella on the northern mainland coast. Areas of waterbird concentrations around Stubbs Island, Bunsby Islands, Sea Otter Cover and Chesterman's Beach (an internationally important area for shorebird migrations) were also impacted. 5 refs., 11 figs., 7 tabs.

30063 (OME/WRB–90-01802) **Preliminary report for the first six months of monitoring in the petroleum refining sector (December 1, 1988 to May 31, 1989).** Ontario Ministry of the Environment, Toronto, ON (Canada). Water Resources Branch. Dec 1989. 37p. (MICROLOG–90-01802). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Petroleum Refining Sector Effluent Monitoring Regulation was promulgated in June 1988 and amended in November 1988 to further clarify requirements. Except for an initial reporting requirement, which came into force September 1988, the Regulation came into force December 1988. During the monitoring period, data were collected by industry under strict protocols to ministry specifications. Companies were also required to carry out a quality control program to help validate the monitoring data. Besides flow monitoring and sampling for chemical analyses, the dischargers were also required to perform toxicity testing on their process effluents and once-through cooling water. As some validations of data are pending, only the first 6 months of data were reviewed for this report. Preliminary analyses of data shows that the performance of the refineries is about as expected regarding effluent quality, with 1 out of 6 process effluent samples lethal to both rainbow trout and Daphnia Magna. The newer refineries have lower loadings of contaminants in their effluents than the older refineries. There is still room for improvement in waste water treatment, through updating the equipment, process changes and improving operating practices. Spills continue to be a problem for the sector. 10 tabs., 15 figs.

30064 (PACE–87-2) **Sampling and analysis of refinery effluents to assess variations in trace contaminant concentrations.** Petroleum Association of Conservation of the Canadian Environment, Ottawa, ON (Canada). Aug 1987. 100p. (MICROLOG–90-01935). Available from PC Petroleum Association for Conservation of the Canadian Environment (PACE), 1202-275 Slater St., Ottawa, ON, CAN K1P 5H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study was conducted in fulfillment of the preregulation monitoring requirements under Ontario's Municipal Industrial Strategy for Abatement program for the petroleum sector and was intended to define the capability of petroleum refinery biological treatment processes to effect trace contaminant removal and to assess the variability of effluent quality. A comprehensive sampling program was carried out at the Esso Petroleum Canada Refinery in Sarnia and the Petro-Canada Trafalgar Refinery in Oakville. Six-hour flow-proportioned composite samples of the influent and effluent from the biological treatment plants at each refinery were collected on 6 occasions over 2 weeks. During the sampling periods, biological treatment system operating conditions and key refinery operating conditions were documented. The analytical program focused on conventional contaminants, metals, selected volatile aromatic compounds and polynuclear aromatic hydrocarbons. A comprehensive quality assurance program was conducted in conjunction with the sampling and analytical components of the investigation. The biological treatment plants at both refineries were consistently capable of highly efficient removal of trace organic contaminants. Effluent quality was similar at both refineries for trace organic contaminants despite significant differences in influent quality, refinery size and complexity, and biological treatment plant design and operations. 5 refs., 8 figs., 14 tabs.

30065 (PB–90-161787/XAB) **Seabird oil toxicity study. Final report.** Fry, D.M. Nero and Associates, Inc., Portland, OR (USA). Feb 1987. 187p. Available from NTIS, PC A09/MF A01.

See also PB–84-179522.

The objective of the study was to investigate short- and long-term effects of oil exposure on three species of seabirds: Cassin's Auklet (Ptychoramphus aleuticus), Common Murre (Uria aalge), and Wedge-tailed shearwater (Puffinus pacificus). Field studies with auklets were carried out on Southeast Farallon Island (SEFI), 40 km west of San Francisco, using 500 artificial nesting burrows. Cassin's Aulkets were dosed with 1 ml weathered oil either orally by gelatin capsule or externally by application to the breast plumage. The data strongly support the hypothesis that breeding failure after oil exposure resulted in mate switching which caused overall lowered breeding success in both Cassin's Auklets and Wedge-tailed shearwaters.

30066 (PB–90-178880/XAB) **Superfund Record of Decision (EPA Region 4): Newsom Brothers/Old Reichhold, Columbia, MS. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 18 Sep 1989. 88p. (EPA/ROD/R–04-89/050). Available from NTIS, PC A05/MF A01.

The 81-acre Newsom Brothers/Old Reichhold site is in Marion County, Columbia, Mississippi. Site activities included producing tall oils, turpentine, calcium and zinc resinates, and polymerized and rubber resins. Furthermore, PCP was apparently mixed with diesel oil and sold, and xylenes were used in a number of processes. A State investigation in 1976 revealed that waste water containing phenols, oil, and grease was discharging to a small creek. Further investigations resulted in EPA performing an immediate removal action in 1984, which included the removal of over 600 surface drums from the site and excavating and draining two ponds, one of which was subsequently filled with clean fill. Onsite buried drum areas were the target of another EPA removal action conducted in 1987-88. In addition there is an extensive system of concrete drains that served to collect and drain spilled wastes and rain water that has

an area of runoff of approximately 300,000 square feet. The primary contaminants of concern in the soil, sediment, and bulked wastes are organics including PAHs, PCBs, and PCP, and metals.

30067 (PB–90-862525/XAB) **Aquatic plants: Ecology and environment. January 1977-November 1987 (a Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-November 1987.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 176p. Available from NTISPC N01/MF N01.

See also PB–90-862533.

This bibliography contains citations concerning growth of, and ecological and environmental effects on, benthic flora in lakes, rivers, and coastal areas. Effects of domestic sewage, industrial wastes, and oil spills on benthic ecosystems are discussed. Benthic algae vegetation in river and polluted areas is considered, and benthic algae as biological indicators of water quality are also discussed. (This updated bibliography contains 325 citations, none of which are new entries to the previous edition.)

30068 (PB–90-862533/XAB) **Aquatic plants: Ecology and environment. December 1987-December 1989 (a Bibliography from the Selected Water Resources Abstracts data base). Report for December 1987-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 61p. Available from NTISPC N01/MF N01.

Supersedes PB–88-853189. See also PB–90-862525.

This bibliography contains citations concerning growth of, and ecological and environmental effects on, benthic flora in lakes, rivers, and coastal areas. Effects of domestic sewage, industrial wastes, and oil spills on benthic ecosystems are discussed. Benthic algae vegetation in river and polluted areas is considered, and benthic algae as biological indicators of water quality are also discussed. (This updated bibliography contains 81 citations, all of which are new entries to the previous edition.)

30069 (PB–90-862699/XAB) **Oil-pollution sampling, detection, and analysis. April 1976-March 1990 (a Bibliography from the NTIS data base). Report for April 1976-March 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 192p. Available from NTISPC N01/MF N01.

Supersedes PB–89-856736.

This bibliography contains citations concerning the monitoring and analysis of oil pollution resulting from production and transport operations. Descriptions and evaluations of monitoring methods and devices, tagging and tracing techniques, and analytical techniques, including spectroscopy and chromatography, are among the topics reviewed. Remote sensing methods and oil-laden sediment sampling and analyses are also considered. While the majority of the citations pertain to marine pollution, some attention is given to terrestrial aspects. Citations pertaining specifically to pollution effects on flora and fauna are excluded. (This updated bibliography contains 350 citations, 34 of which are new entries to the previous edition.)

0210 Legislation and Regulations

Refer also to citation(s) 30061

30070 (PACE–88-4) **Comparison of the effluent monitoring requirements for specific U.S. petroleum refineries to proposed Ontario Ministry of the Environment Regulations.** Petroleum Association of Conservation of the Canadian Environment, Ottawa, ON (Canada). Nov 1988. vp. (MICROLOG–90-01924). Available from PC Petroleum Association for Conservation of the Canadian Environment (PACE), 1202-275 Slater St., Ottawa, ON, CAN K1P 5H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The draft effluent monitoring regulations for petroleum refineries issued by Ontario's Ministry of the Environment (MOE) were compared to U.S. Environmental Protection Agency (U.S. EPA) recommendations and National Pollutant Discharge Elimination System (NPDES) permits for 34 petroleum refineries in states surrounding the Great Lakes. Major differences in the number and frequency of parameters monitored between U.S. EPA guidelines, MOE draft regulations, and individual NPDES permits were noted. MOE draft regulations require each facility to chemically characterize its process effluents by monitoring for 155 parameters once every 3 years. Additional monitoring consists of monitoring for 110 chemicals 3 times quarterly, 12 chemicals 3 times weekly, and 3 chemicals daily. In contrast, U.S. EPA requires each petroleum refinery to chemically characterize its process effluents by monitoring for 75 parameters once every 5 years as part of its NPDES permit application/renewal. Of all the facilities surveyed, only 92 of the 155 compounds required to be monitored by MOE were monitored by at least one U.S. facility. In general, most states in this survey focus on monitoring conventional and nonconventional pollutants (e.g., pH, TSS, BOD) as opposed to organic priority pollutants. 6 tabs.

0220 Transport, Handling, and Storage

Refer also to citation(s) 30043, 30662

30071 (BC/P–90-01762) **Report to the Premier on oil transportation and oil spills.** Anderson, D. British Columbia Premier, Victoria, BC (Canada). Nov 1989. 155p. (MICROLOG–90-01762). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report is the result of 4 months of public hearings in the coastal communities of British Columbia over the summer of 1989 on recommendations to reduce marine oil spill risks and to improve response capability. The report considers the problems of oil transportation and oil spills without regard for questions of jurisdiction. Prevention, response and compensation for damage are discussed. Methods of prevention include reducing consumption of products and increased recycling along with government support of energy conservation and alternative forms of energy; no expansion of crude oil exports from the Port of Valdez; and reduction of the chance of tanker breaching by reclassifying tankers to Type 1 cargoes and upgrading standards to all vessels in the area including tugs and barges to the highest in either Canada or the U.S. Methods of preparation emphasize a quick response to spills as the most vital component, therefore on-board spill response equipment for tankers and barges is recommended, along with changes to equipment or procedures on shore, such as upgrading of radar systems and staff, as well as more extensive research in oceanography. A spill response-incident scenario is included. Compensation is discussed through voluntary plans, international agreements, Canada's ship-source oil pollution fund, insurance, and U.S. legislation, with recommendations to increase the funds in Canada's oil pollution fund and to coordinate with international agencies in compensating spills.

30072 (DOE/CE/15397–T5) **TBS prototype test program: In service tank bottom leak detection and repair system: Technical progress report, quarter ending March 31, 1990.** Lewis, D.E. Lewis Engineering and Project Management, Inc., Corpus Christi, TX (USA). [1990]. 14p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15397. Order Number DE90010048. Available from NTIS, PC A03/MF A01 - OSTI.

This progress report discusses activities and plans to test a new leak detector and leak stopper on a petroleum tank. Included in the report is a newsletter, an audit, and a schedule of events. (FSD)

0230 Properties and Composition

Refer also to citation(s) 30044

0250 Combustion

30073 **Means for proving oxygen enrichment for slurry and liquid fuel burners.** Hansel, J.G. To Air Products and Chemicals, Inc., Allentown, PA. USA Patent 4899670/A/. 13 Feb 1990. Filed date 9 Dec 1988. USA Patent Application 7-282,156. Int. Cl. F23D 1/02. vp.

This patent describes a fuel burner. It comprises: a central axial fuel nozzle, a first annular shell defining a first passage surrounding the nozzle for delivery of primary oxidant gas, a combustion zone downstream of the nozzle where the fuel is combusted with the gas and a diffuser plate for swirling the gas into the combustion zone. The diffuser plate has a series of vanes emanating radially outward from the fuel nozzle. The vanes include conduit means for dispensing oxygen-enriched gas to the primary oxidant gas such oxygen-enriched gas supplied by a pipe means.

03 NATURAL GAS

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 30041, 30042, 30052

30074 (CRPC–90-01995) **Sour gas study of the Calgary Region.** Calgary Regional Planning Commission, AB (Canada). Aug 1985. 105p. (MICROLOG–90-01995). Available from PC Calgary Regional Planning Commission, Library, 4303-11 St. SE, Calgary, AB, CAN T2G 4X1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study was initiated in response to a request from the Alberta Energy Resources Conservation Board (ERCB) that the Commission become more involved in the land use implications of sour gas development in the Region. This report includes an inventory of proven and potential reserves and facilities; a description of the regulation and control agencies of the sour gas industry; an overview of the land use planning policies of the Region; and a review of the potential conflicts or relationships between the use of the land and the continued development of the sour gas industry. The report also describes potential conflict areas in detail and examines management strategies to reduce potential conflicts between surface and subsurface development. An analysis of the preliminary data and the resulting recommendations, as endorsed by the Commission, is included. The findings of the study indicate that the approval process and regulations established and implemented by the ERCB are adequate. The recommendations provide a method of monitoring sour gas development within the Region and focus attention on the important issue of minimizing potential land use conflicts. 43 refs., 9 figs., 5 tabs.

30075 (PB–90-172537/XAB) **Petrophysical properties and network models of gas-bearing reservoir rocks. Annual report, October 1988-November 1989.** Stanford Univ., CA (USA). Dept. of Geophysics. Nov 1989. 46p. Available from NTIS, PC A03/MF A01.

See also PB–89-214068.

A three-part pattern recognition algorithm was developed that can be used to define connected pathways for fluid flow from petrographic thin sections or to classify geological features from remote-sensing or petrographic images. Studies continue on the effect of clay on acoustic velocities in tight gas sandstones. A new formulation was developed to quantify the effects of grain-scale local flow on dynamic elastic modulus dispersion.

0303 Drilling, Production, and Processing

Refer also to citation(s) 30052, 30054, 30088, 30089

30076 (SAND–90-0759) **Enhanced gas recovery bibliography, Sandia National Laboratories, December 1975–December 1989.** Northrop, D.A. (comp.). Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 32p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. Order Number DE90010166. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories has conducted research and development in the area of enhanced or unconventional natural gas recovery since the mid-1970's. This report is a compilation, in chronological order, of the formal documentation that has resulted from that work. Since its inception, this R&D has covered five general areas, which evolved in roughly the following order: instrumentation, mineback experimentation, propellant fracturing, multiwell experiment, and geoscience. The Department of Energy's U:nconvetnional Gas Program has been the predominant sponsor ofthe work represented in this bibliography. All entries of this bibliography are reports, papers, and abstracts which are available publicly – either in published journals or as reports available through the National Technical Information Service, US Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. The Journal of Petroleum Technology and other Society of Petroleum Engineers publications contain many of the journal papers. Sandia National Laboratories reports are the majority of the published reports. Abstracts are included only if they were published.

30077 **Field measurements of dynamic pressure and seismic activity during foam fracturing.** Locke, C.D. (BDM Corp. (USA)); Overbey, W.K.; Yost, A.B. pp. 550 of Proceedings of the SPE gas technology symposium: Serving a competitive market. Society of Petroleum Engineers, Richardson, TX (USA) (1989). (CONF-890644–: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989).

SPE 18555.

Results of a highly-instrumented multiple-well field test to measure pressure responses during hydraulic stimulation of a naturally-fractured gas reservoir are presented. The field test consisted of a 70,000 gallon foam frac in one of four test wells while monitoring bottomhole pressures in each of the four wells and monitoring the site with an array of tiltmeters. A 75-quality sand-laden foam was injected into the naturally fractured formation at a rate of 20 bbl/min. Bottomhole pressures were monitored in the fraced well and in three observation wells. Tiltmeters were installed at 12 surface locations encircling the stimulated well at distances of approximately 600 to 1000 feet (180 to 300 meters) to aid in determining the geometry of the induced fracture. The tiltmeter and pressure responses were analyzed in conjunction with pre- and post-stimulation interference tests to obtain fracture geometry. Eight of the twelve tiltmeters gave clear and analyzable responses. Application of computer codes to the field data provided estimates of fracture geometry caused by the treatment.

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30059, 30458, 30491

30078 (DOE/EIA–0130(90/02)) **Natural gas monthly, February 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Oil and Gas. 26 Apr 1990. 145p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90010517. Available from NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.

The NGM highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. From time to time, the NGM features articles designed to assist readers in using and interpreting natural gas information 7 figs., 34 tabs.

30079 (PB–90-167636/XAB) **Congeneration and Gas Cooling research status report, 1985-1986.** Gas Research Inst., Chicago, IL (USA). Sep 1986. 130p. (GRI–86/7019). Available from NTIS, PC A07/MF A01.

See also PB–88-130265.

This status report contains information on activities within GRI's Cogeneration and Gas Cooling Department during 1985-1986. The funding rationale, goals and objectives, accomplishments, and strategies are described for these project areas: Commercial heating and cooling systems, Fuel-cell systems, and Energy cogeneration systems.

30080 (PB–90-172503/XAB) **Radiant-burner technology base - burner research and development. Final report, February 1986-January 1989.** Tidball, R.K.; Donaldson, R.J.; Gorrerba, J.A. Alzeta Corp., Santa Clara, CA (USA). Mar 1989. 246p. Available from NTIS, PC A11/MF A02.

See also PB–88-245717. Color illustrations reproduced in black and white.

The objective of the three-year project was to improve the technology of direct, gas-fired, surface-combustion radiant burners to promote their wider application in industrial process-heating applications. Four types of burners were considered, including Ceramic Fiber, Ported Ceramic Tile, Porous Ceramic Foam, and Sintered Metal Fiber constructions. For each of these, specific goals included increasing surface firing capacities, reducing materials degradation, and determining radiant output over the useful operating range of each burner. This was achieved by characterizing thermal and combustion performance and degradation mechanisms, and developing design materials, and fabrications improvements to achieve acceptable durability in industrial process heating environments. All literature collected during the project was compiled into a data base for access through GRI's Library Services DIALOG information service. The project had several significant results. First, a large body of applications data was generated which can be used to properly match advanced burners to specific industrial processes. A ceramic fiber burner formulation was developed that increases life in severe industrial environments by over a factor of two. The sintered metal fiber burner demonstrated even longer lifetime in these environments. Improvements were identified for porous ceramic foam burners.

30081 (PB–90-178773/XAB) **GRI (Gas Research Institute) high temperature ceramics workshop. Final report, February-December 1983.** Rowcliffe, D.J.; Johnson, S.M. SRI International, Menlo Park, CA (USA). Nov 1984. 259p. Available from NTIS, PC A12/MF A02.

The objective of the program is to evaluate the research needs concerned with the application of structural ceramics to the development of advanced gas-fired systems and provide a set of recommendations for future research to GRI. The main approach to gathering information was through the GRI High Temperature Ceramics Workshop held in Chicago on April 21-22, 1983. The proceedings of the Workshop provide a basis for recommendations that GRI make a substantial commitment to long-term research and that GRI focus most of its available funds in a single area related to corrosion and oxidation; each year the program should be expanded to include new projects on fabrication techniques and new materials, joining and coatings, and life prediction for large systems. An important part of the program would be an effort to identify technology developed under sponsorship of other agencies. Failure to fund research at a significant level will seriously impede GRI's ability to develop fuel-efficient gas-fired systems and achieve gas-industry goals of increased market share.

30082 (PB–90-178963/XAB) **Factors affecting the competitive position of natural gas in industrial process-heat applications (summary).** Energy and Environmental Analysis, Inc., Arlington, VA (USA). 1984. 7p. Available from NTIS, PC A02/MF A01.

See also PB–85-149805.

A GRI-sponsored project was conducted to evaluate the competitive position of natural gas in industrial process-heating applications and to estimate the extent to which gas use may be vulnerable to competition from other energy forms. Results are summarized in tables and charts.

0308 Environmental Aspects

Refer also to citation(s) 29995, 30494, 31351

0310 Legislation and Regulations

Refer also to citation(s) 30074

0320 Transport, Handling, and Storage

30083 (PB–90-178781/XAB) **Theory for accelerated slow crack propagation in polyethylene fuel pipes. Annual report, 1985-1986.** Moet, A.; Chudnovsky, A.; Sehanobish, K.; Kasakevich, M.L. Case Western Reserve Univ., Cleveland, OH (USA). Apr 1986. 162p. Available from NTIS, PC A08/MF A01.

See also PB–86-136454.

This report describes results along two major directions in efforts to develop a theory for accelerated test of polyethylene (PE) fuel pipe. The entire history of accelerated, stable, brittle crack-propagation behavior was reproducibly observed in PE 2306-II pipe specimens. Residual stresses together with morphological gradients exhibit striking influence on crack propagation within the pipe wall. The Crack Layer theory was employed to describe the crack propagation behavior in high-density polyethylene (HDPE) which is used as a model material. The specific enthalpy of damage, a material parameter reflecting its resistance to fracture, was calculated from both creep and fatigue crack-propagation experiments to be on the order of 10 cal/g.

0330 Properties and Composition

30084 (PB–90-172495/XAB) **Feasibility of a microcalorimeter sensor for the continuous measurement of the BTU content of natural gas. Final report, May 1988-February 1989.** Stetter, J.R.; Findlay, M.W.; Yue, C. Transducer Research, Inc., Naperville, IL (USA). Jun 1989. 20p. Available from NTIS, PC A03/MF A01.

Current methods for measuring the heat content of natural gas are based upon large, expensive instruments, such as the Cutler-Hammer calorimeter (in which the gas is combusted) or gas chromatographs (which perform composition analysis). Although very precise, these techniques are expensive, labor-intensive, and not very mobile. An inexpensive, accurate BTU meter would be extremely useful in the transport and storage of natural gas. Several benchtop experiments were conducted in order to test the feasibility of using a TRI microsensor as a calorimeter. An analysis of BTU content was performed each three minutes for more than 4500 samples of a one month period. An analysis of the heat content of different gas compositions and four authentic natural gas samples was performed with a precision better than plus or minus 0.02% in the best cases. The potential accuracy was estimated to be easily better than plus or minus 0.5% but the performance of the device as a primary standard was not confirmed herein. These data were compared to a theoretical model and the issues of error, precision, feasibility, and accuracy were discussed. During the project, feasibility was established and a design for a portable field device was proposed.

0340 Combustion

Refer also to citation(s) 30629, 30941, 30946

30085 (PB–90-162983/XAB) **NOx chemistry in natural gas flames. Annual report, May 1988-May 1989.** Zabielski, M.F.; Woody, B.A. United Technologies Research Center, East Hartford, CT (USA). 31 May 1989: 43p. (UTRC–957376-6). Available from NTIS, PC A03/MF A01.

See also PB–89-103915.

The results of model calculations of NO_2 formation and removal in flat hydrogen flames are presented. A calibration technique for quantitatively measuring CH with FM spectroscopy is described. CH data obtained on NO-seeded and unseeded methane flames with stoichiometries (Phi) of 0.92, 1.13, and 1.27 are presented along CH data from a Phi = 0.98, oxygen enriched, methane flame. With a dye laser, modified to operate in the ultraviolet, and an improved crystal modulator cavity, FM measurements of CN at 388 nm are described. A method for calibrating the FM technique to measure CN quantitatively is also included. Raw CN data (optical emission and FM absorption) obtained in the NO seeded flames are presented. These measurements represent the first application of FM spectroscopy in the ultraviolet spectral region.

04 OIL SHALES AND TAR SANDS

0402 Reserves, Geology, and Exploration

30086 (PB–90-182254/XAB) **Barite nodules in Devonian shale and mudstone of western Virginia. Bulletin.** Clark, S.H.B.;

Mosier, E.L. Geological Survey, Denver, CO (USA). 1989. 39p. (USGS-BULL--1880). Available from NTIS, PC A03/MF A01.

Library of Congress catalog card No. 88-600455.

The objectives of the study were to locate and describe the barite occurrences in shale and mudstone of western Virginia and to find out whether the geochemistry of the shale and mudstone, together with the physical features of the nodules and enclosing rocks, would help determine if the nodules had been formed by submarine spring activity in the area or if they had originated in some other way. The report describes the barite nodules, presents the results of chemical analyses of the enclosing shales, and describes the depositional environments in which the barite nodules formed. The report evaluates the features of the nodules and enclosing rocks and suggests a feasible model for the origin of the observed features.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 29966, 30055

30087 (DOE/MC/25043–2804) **Solvent extraction of southern US tar sands: Final report.** Arkansas Univ., Fayetteville, AR (USA). Dept. of Chemical Engineering. May 1989. 279p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG21-88MC25043. Order Number DE90000464. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

The socioeconomic aspects of the tar sands recovery were investigated by Diversified Petroleum Recovery, Inc. Mineral Resources Institute at the University of Alabama conducted characterization and beneficiation studies on Alabama tar sands. Two sources in the state were identified, namely, Black Wax Hill and Spring Creek. Samples were obtained, beneficiated, then shared with the University of Arkansas. The University of Arkansas conducted research in three areas, namely, solvation and characterization of the tar sands phase equilibria as well as the design and operation of a bench-scale batch model. In the solvation studies, the results indicate that grinding the tar sands too fine results in downstream processing problems. Also, preliminary indications are that the beneficiation step may not be necessary in the solvation of the bitumen. The phase equilibria of the heptane/brine/isopropyl alcohol/XTOL™ system is very complex. The salt concentration of the brine is significant in the partitioning of the isopropanol and heptane. Equilibrium data for some of the various combinations of chemical constituents have been obtained. Also included are appendices: statistical data on highways; petrography; Dean-Starke technique; FTIR and NMR spectra; FORTRAN computer program for GC; simulation of flash behavior for IPA/brine/fatty acid/N-C_7 mixture; and previous progress reports. 32 figs., 28 tabs.

30088 (PB–90-178930/XAB) **Geostatistical analysis of Devonian shale stratigraphic, production, and completion data in West Virginia. Annual report, July 1, 1984-June 30, 1985.** Hohn, M.E. West Virginia Geological and Economic Survey, Morgantown, WV (USA). Jul 1985. 43p. Available from NTIS, PC A03/MF A01.

See also PB–87-134086.

An oil and gas report on Pleasants, Wood, and Ritchie Counties was written and is under review. It includes sections on stratigraphy, structure, drilling history, production, and completion methods, as well as structure contour maps, maps of wells producing in major intervals, and interlocking cross-sections. A similar report was written in part for Wirt, Roane, and Calhoun Counties, and preliminary studies were begun for a report on Mingo, Logan, and Lincoln Counties, including maps of gas initial potentials and probability of success. A data base of production, stratigraphy, pays, and completion technology was created in part, and some data in a master oil and gas data base were edited and corrected for transfer to the Devonian shale data base. Computer software was developed for geostatistical calculations and mapping, display of well locations, display of stratigraphic data and occurrences of shows and pays, assignment of pays to stratigraphic intervals, editing of data, and data input.

30089 (PB–90-178948/XAB) **Study of hydrocarbon production from the Devonian shale in Letcher, Knott, Floyd, Martin, and Pike Counties, eastern Kentucky annual technical report, July 1, 1984-June 30, 1985.** Frankie, W.T. Kentucky Univ., Henderson, KY (USA). Kentucky Geological Survey. Jul 1985. 49p. Available from NTIS, PC A03/MF A01.

The Kentucky Geological Survey (KGS) at the University of Kentucky is conducting a 2-year research project funded by the Gas Research Institute (GRI) to study hydrocarbon production from the Devonian shale in eastern Kentucky. Objectives are to develop an understanding of relationships between stratigraphy and hydrocarbon production, create a data base, and prepare geologic reports for each county in the study area. Data were compiled from the KGS, GRI Eastern Gas Data System (EGDS), U. S. Department of Energy (DOE), and industry. Research for Letcher County was completed and 270 Devonian wells were entered into the KGS computer data base. Devonian black-shale units were correlated using gamma-ray logs. Structure and isopach maps, and stratigraphic cross sections have been constructed. An isopotential map defining areas of equal initial gas production has been prepared. Statistics for Letcher County have been run on the data base using Datatrieve software package. Statistical analyses focused on different types of formation treatments and the resulting production. Temperature logs were used to detect gas-producing intervals within the Mississippian-Devonian black-shale sequence. The results of the research provide the petroleum industry with a valuable tool for gas exploration in the Devonian shales.

30090 Method and apparatus for hydrocarbon recovery from tar sands. Westhoff, J.D.; Harak, A.E. To Dept. of Energy, Washington, DC. USA Patent 4880528/A/. 14 Nov 1989. Filed date 4 May 1988. USA Patent Application 7-188,324. Int. Cl. C10G 1/02. 8p.

A method and apparatus or utilizing tar sands having a broad range of bitumen content is disclosed. More particularly, tar sands are pyrolyzed in a cyclone retort with high temperature gases recycled from the cyclone retort to produce oil and hydrocarbon products. The spent tar sands are then burned at 2000°F in a burner to remove residual char nd produce a solid waste that is easily disposable. The process and apparatus have the advantages of being able to utilize tar sands having a broad range of bitumen content and the advantage of producing product gases that are free from combustion gases and thereby have a higher heating value. Another advantage is rapid pyrolysis of the tar sands in the cyclone so as to effectively utilize smaller sized reactor vessels for reducing capitol and operating costs.

0405 Properties and Composition

Refer also to citation(s) 30087, 30090

30091 (DOE/MC/11076–2788) **Chemical equilibria model analysis of Hope Creek eastern oil shale lysimeter leachate data.** Essington, M.E. Western Research Inst., Laramie, WY (USA). Sep 1989. 74p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000457. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Leachates from field lysimeters containing an eastern oil shale, a retorted eastern oil shale, and an oil shale fines/retorted oil shale mixture were subjected to chemical equilibria analysis by the GEOCHEM model. Results of the chemical equilibria model analysis provided a more detailed characterization of the chemistry of oil shale materials. The aqueous chemistry of the lysimeter leachates is dominated by free ionic metal species and metal sulfate ion pairs. Activity diagrams shows that free metal ion activities (with the exception of Ca^{2+}) are directly related to SO_4^{2-} activities. This suggests that the aqueous activities of the metals examined are not supported by metal sulfate solid phases. However, an examination of metal sulfate ion activity products (IAPs) as a function of time shows that the IAPs approach constant values after approximately 800 days of the field study. For the great majority of the metals examined, the IAP values suggest leachate undersaturation with respect to even the most stable metal sulfate phases. Leachates from all three materials are predicted by GEOCHEM to approach equilibrium with respect to gypsum and goethite. In addition, leachates from the oil shale lysimeter are predicted by GEOCHEM to approach equilibrium with respect to melanterite, Fejurbanite, franklinite, molybdite, and molybdic acid. Aluminum

activities in all three lysimeter leachates fall within the stability region of several basic aluminum sulfates. However, Al^{3+} activities in the lysimeter leachates are not supported by sulfate phases. 34 refs., 15 figs., 2 tabs.

0406 Products and By-Products

Refer also to citation(s) 30087, 30092

0407 Health and Safety

Refer also to citation(s) 30093

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30087

30092 (DOE/MC/11076–2759) **Niche market assessment for a small-scale western oil shale project.** Sinor, J.E. (Sinor (J.E.) Consultants, Inc., Niwot, CO (USA)). Western Research Inst., Laramie, WY (USA); Sinor (J.E.) Consultants, Inc., Niwot, CO (USA). Jul 1989. 149p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-86MC11076. Order Number DE90000413. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

As part of an overall program to study the economic feasibility of a small-scale western oil shale project, Western Research Institute requested J. E. Sinor Consultants Inc. to carry out a marketing analysis for the potential products. In undertaking such a study, it was recognized that the production of conventional fuels, such as gasoline, jet fuel and diesel fuel, would not be feasible under current economic conditions. Therefore, the approach used in this study was to focus on nonconventional products, having perhaps a small potential market size but providing an opportunity to sell shale oil at considerably more than its crude oil equivalent price. To find such potential market niches, it is necessary to emphasize and preserve the differences between shale oil and petroleum, rather than try to make shale oil simply a substitute for petroleum. The objectives of this analysis are to identify potential products; to determine the size of the existing market for these products; to estimate the prices that such products could receive; and to evaluate all factors influencing the ability to sell shale oil products in these markets. 23 refs., 47 figs., 52 tabs.

0410 Environmental Aspects

Refer also to citation(s) 30091

30093 (PB–90-171489/XAB) **Fire and explosion hazards of oil shale. Report of Investigations/1989.** Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 73p. (BUMINES-RI–9281). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs. Library of Congress catalog card No. 88-600341.

This publication presents the results of investigations into the fire and explosion hazards of oil-shale rocks and dust. Three areas were examined: the explosibility and ignitability of oil-shale dust clouds, the fire hazards of oil-shale dust layers on hot surfaces, and the ignitability and extinguishment of oil shale rubble piles.

30094 (PB–90-177031/XAB) **Unocal Parachute Creek Shale Oil Project. Monitoring Review Committee meeting report, August 15, 1989.** Unocal Corp., Parachute, CO (USA). Energy Mining Div. 1989. 79p. (OSFP/PC–0017). Available from NTIS, PC A05/MF A01.

See also PB–89-191043 and PB–89-159172.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic-fuels plants. The support agreement included development of an Environmental Monitoring Plan, incorporating existing compliance monitoring and supplemental monitoring on water, air, solid waste, worker health and safety, and socio-economic impacts during the period 1986-1993. Phase I of the project is to produce 10,000 barrels per day of syncrude from oil shale, using the Unishale B process. Results of supplemental monitoring at 18 sites, including particulates, gases, liquids and solids, are discussed by representatives from the U.S. Department of Energy, U.S. Environmental Protection Agency, the Colorado Department of Natural Resources and the U.S. Department of Treasury.

30095 (PB–90-179508/XAB) **Unocal Parachute Creek Shale Oil Program. Environmental Monitoring Plan quarterly report. Third quarter, 1989. Report for 1 July-30 September 1989.** Unocal Corp., Parachute, CO (USA). Energy Mining Div. 30 Nov 1989. 432p. (REPT–89-3Q). Available from NTIS, PC A19.

Portions of this document are not fully legible.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic-fuels plants. The Parachute Creek Shale Oil Program is one of four projects awarded financial assistance. The support agreement included development of and Environmental Monitoring Plan, incorporating existing compliance monitoring and supplemental monitoring on water, air, solid waste, worker health and safety, and socio economic impacts during the period 1986-1993. Phase I of the project is to produce 10,000 barrels per day of syncrude from oil shale, using the Unishale B process. A description of Compliance activities completed during the quarter and copies of agency reports are given in the document. Supplemental sampling for industrial hygiene also is described.

0440 Combustion

30096 (CICS–CE02996, pp. 3-5) **The bubbling fluidized bed combustion of liquid fuels.** Zhang, J.Q. (Energy Research Laboratories, CANMET, Ottawa, ON (Canada)); Anthony, E.J.; Desai, D.L.; Friedrich, F.D. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Fluidized bed combustion (FBC), which can burn fuels in an environmentally benign way, appears to be a promising technology. Consequently three liquid fuels: No.6 oil, bitumen and CANMET pitch were tested in the pilot-scale FBC rig at the Combustion and Carbonization Research laboratory (CCRL). The primary aims of the project were to develop an appropriate feed system for heavy liquid fuels and to gain operating experience burning them. No.6 oil was chosen as the candidate fuel for the development of the feed system since its physical properties are similar to those of the bitumen and pitch. A secondary aim was to examine combustion performance in terms of combustion efficiency and pollutant emissions, and thus contribute to the understanding of the feasibility of using these materials as fuels. The emission of hydrocarbons was examined for only a few of the tests with the pitch but appeared to be negligible, and ranged from 110 to 500 ppm. The mass balance for carbon was also fairly good ranging around 85% to 110% with a mean close to 100%. Combustion efficiencies calculated on an energy basis varied from 98.5% to 99.6% suggesting that bubbling bed can burn such fuels efficiently. 1 ref., 1 tab.

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 30888, 31349

30097 Model design for sequential decisions based upon evaluation of exploration information by capital markets: Case study, roll-type uranium deposits. . Harris, D.P. (Arizona Univ., Tucson, AZ (USA). Dept. of Mining and Geological Engineering). pp. 1124 of 20087. Society of Mining Engineers of AIME, Littleton, CO (USA) (1989). (CONF-8902116–: APCOM '89: 21. international symposium on application of computers and operations research in the mineral industry, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

The structure if an exploration model reflects a number of design considerations, one of which is the question or issue to be investigated by the model. Thus, a model designed to evaluate the magnitude of risk and its economic implications to optimal decision making at each decision juncture of a multistage exploration architecture differs considerably from one designed to evaluate, say, the long run average cost of discovery, in which the architecture of exploration is suppressed and risk is simply an element of average cost.The perspective of the model examined in this paper is that exploration is investment in information and that the next stage of an exploration program is undertaken only when the expected value of information to be acquired in that stage exceeds its cost. It is concluded that the degree to which this perspective is honored influences considerably model design.

0504 Feed Processing

Refer also to citation(s) 29956

30098 (CNIC–00092) **The miniature annular centrifugal contactor for laboratory use.** Zhang Zefu (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Ding Dachun; Tang Quanyong. China Nuclear Information Centre, Beijing, BJ (China). Oct 1987. 9p. (In Chinese). (IAE–0026). Order Number DE90626198. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The 22mm-di. annular centrifugal contactor including single-stage and eight-stage contactor have been designed. And the hydraulic and masstransfer tests have been carried out. Results showed that when the diameter of heavy phase weir is 12.5 mm, for single stage contactor, the operable ranges are as follows: total flow rate is about 15 ml/min, O/A flow ratio of 0.1 $\approx$ 10, rotor speed about 3000 $\approx$ 4000 r/min, $\rho o/\rho A$ density ratio 0.64 $\approx$ 0.88; for eight stage contactor, the operable ranges are the same of those of single stage contactor except density ratio ranges which are 0.64 $\approx$ 0.82. Stage efficiencies measured by the extraction of nitric acid and uranium are greater than 95% in the case of both single stage one and eight stage one. Therefore they are suitable for laboratory use in studies solvent extraction technology.

30099 **Enclosed rotary disc air pulser.** Olson, A.L.; Batcheller, T.A.; Rindfleisch, J.A.; Morgan, J.M. To Dept. of Energy, Washington, DC. USA Patent 4881574/A/. 14 Nov 1989. Filed date 12 Aug 1988. USA Patent Application 7-231,427. Int. Cl. F16K 11/06. 8p.

This patent describes an enclosed rotary disc air pulser for use with a solvent extraction pulse column. It includes a housing having inlet, exhaust and pulse leg ports, a shaft mounted in the housing and adapted for axial rotation therein, first and second disc members secured to the shaft within the housing in spaced relation to each other to define a chamber therebetween. THe chamber is in communication with the pulse leg port. The first disc member is located adjacent the inlet port. The second disc member is located adjacent the exhaust port. Each disc member has a milled out portion. The disc member are positioned on the shaft so that as the shaft rotates, the milled out portions permit alternative cyclical communication between the inlet port and the chamber and the exhaust port and the chamber.

0505 Uranium Enrichment

Refer also to citation(s) 30176

0507 Fuels Production and Properties

Refer also to citation(s) 30327, 30887, 30890

30100 (CONF-8909141–10) **Detailed analysis of uranium silicide dispersion fuel swelling.** Hofman, G.L.; Ryu, Woo-Seog. Argonne National Lab., IL (USA). [1989]. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 12. international meeting on reduced enrichment for research and test reactors; Berlin (Germany, F.R.); 10-13 Sep 1989. Order Number DE90010418. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Swelling of U_3Si and U_3Si_2 is analyzed. The growth of fission gas bubbles appears to be affected by fission rate, fuel loading, and microstructural change taking place in the fuel compounds during irradiation. Several mechanisms are explored to explain the observations. The present work is aimed at a better understanding of the basic swelling phenomenon in order to accurately model irradiation behavior of uranium silicide disperson fuel. 5 refs., 10 figs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 30332

30101 (CNIC–00053) **Multistage centrifugal extractor of E92 model.** Wang Houheng (Beijing Inst. of Nuclear Engineering, BJ (China)); Xing Zhifu; Liu Xiangyan; Liu Shi; Wan Yi; Liang Kui; Hu Benyue. China Nuclear Information Centre, Beijing, BJ (China). 1987. 8p. (In Chinese). (BINE–0003). Order Number DE90626206. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The E92 Model multistage centrifugal extractor has been developed for the recovery of uranium and plutonium from spent nuclear reactor fuel. It offers the following advantages: shorter residence time, low hlod-up, less space required, and simplified startup and shutdown procedures, etc. Experiments on performaces of hydraulics, mass-transfer and crud discharging have proved that this unit provides a wide range of operation. The total flow rate can very from 300 to 450 L/h at organic to aqueous flow ratio of 1 to 5. The unit is designed for ratio of oranic to aqueous phase densities at a range of 0.75 to 0.85. Overall extraction and back-extraction efficiencies which is great than 99.99% were achieved using natural uranium as feed. Experiments showed that mechanical assembling and disassembling of the unit could be rapidly carried out. A run continuning up to 500 hours was stable.

30102 (CNIC–00166) **The behaviour of iodine in purex solvent extraction process.** Luo Longjun (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Liu Zhiman. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 8p. (In Chinese). (IAE–0039). Order Number DE90626207. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The behaviour of iodine in the first solvent extraction cycle is investigated on laboratory-scale. The percentages of solvent extraction of Iodine in 1A, 1B and 1C tank were measured. The removal of iodine from organic phase is studied experimentally. The experimental results obtained by ^{131}I tracer show that 72 $\approx$ 74.4% of iodine is entered into 1AP in 1A tank and 2.4% of iodine is entered into 1BP in 1B tank and 1 $\approx$ 2.4% of iodine is entered into 1CU in 1C tank. The tests of back-wash of I-containing 30% TBP-paraffin shows that NaOH solution is able to remove iodine effectively from an organic phase.

30103 (CNIC–00168) **Removal of iodine in dissolution process of nuclear power fuel.** Luo Longjun (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Liu Zhimian; Wang Jinfeng. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 9p. (In Chinese). (IAE–0041). Order Number DE90626208. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The behaviour of iodine in the dissolution process of nuclear fuel is investigated. Unirradiated UO_2 pellets were used in the study. The test shows that possible I^- or IO_3^- can be reduced or oxidized to elemental iodine by HNO_2 present in HNO_3 and produced in dissolution process of UO_2. The result shows that 87 $\approx$ 99.4% of ^{131}I can be removed in the period of 3.5 $\approx$ 6 hours at 95 deg C and boiling point respectively. The adding of stable isotope of iodine to the dissolver can improve the removal of ^{131}I. It is difficult to remove iodine from the solution when the concentration of iodine is lowered down to 10^{-6} mol/L. The strengthening of sparging-air would favour to removal of iodine from dissolver solution. More than 90% of radioiodine goes to gas-off system by sparging-air in the process of dissolution.

30104 (CONF-891013–10) **A new model for solvent extraction in columns.** Leonard, R.A.; Regalbuto, M.C.; Chamberlain, D.B.; Vandegrift, G.F. Argonne National Lab., IL (USA). 8 Dec 1989. 26p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 6. symposium on separation science and technology for energy applications; Knoxville, TN (USA); 22-27 Oct 1989. Order Number DE90010416. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new model was developed for analyzing solvent extraction processes carried out in columns. Each column is treated as a series of well-defined equilibrium stages where the backmixing (other-phase carryover) between stages can be large. By including all mass transfer effects in the backmixing value, the same number of stages can be used for all extracted components no matter what their distribution coefficients. This greatly simplifies the calculations required when modeling multicomponent solvent extraction processes. Initial testing shows the new model to be better than either the Height of an Equivalent Theoretical Plate (HETP) or the Height of a Transfer Unit (HTU) method.

30105 (CONF-900418–13) **Fuel reprocessing data validation using the isotope correlation technique.** Persiani, P.J.; Bucher, R.G.; Pond, R.B.; Cornella, R.J. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90009715. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Isotope Correlation Technique (ICT), in conjunction with the gravimetric (Pu/U ratio) method for mass determination, provides an independent verification of the input accountancy at the dissolver or accountancy stage of the reprocessing plant. The Isotope Correlation Technique has been applied to many classes of domestic and international reactor systems (light-water, heavy-water, and graphite reactors) operating in a variety of modes (power, research, and production reactors), and for a variety of reprocessing fuel cycle management strategies. Analysis of reprocessing operations data based on isotopic correlations derived for assemblies in a PWR environment and fuel management scheme, yielded differences between the measurement-derived and ICT-derived plutonium mass determinations of (-0.02 ± 0.23)% for the measured U-235 and ($+0.50 \pm 0.31$)% for the measured Pu-239, for a core campaign. The ICT analyses has been implemented for the plutonium isotopics in a depleted uranium assembly in a heavy-water, enriched uranium system and for the uranium isotopes in the fuel assemblies in light-water, highly-enriched systems.

30106 (CONF-9006170–1) **Comparison of instrumental methods used in the determination of uranium, plutonium, and americium.** Sabau, C.S. Argonne National Lab., IL (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 15. international ARA congress; Montreal (Canada); 14-18 Jun 1990. Order Number DE90010097. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the use of Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) and Mass Spectrometry-Isotopic Dilution (MSID) for the quantitative determination of plutonium and uranium in different types of samples. 2π - alpha counting and high resolution gamma spectrometry for the analysis of americium and plutonium in scrap, residues, and process samples is also described. Comparison of the data obtained by these methods was presented and evaluated. 11 tabs.

30107 (KFK–4672) **Fiber optic adaptation of the interference filter photometer SPECTRAN for in-line measurements in PUREX process control.** Buerck, J.; Kraemer, K.; Koenig, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Radiochemie; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung. Feb 1990. 60p. (In German). (PWA–72/89). Order Number DE90785074. Available from NTIS (US Sales Only), PC A04/MF A01.

The multicomponent version of the interference filter photometer SPECTRAN was adapted by radiation resistant quartz glass optical fibers to in-line flow cells in the aqueous and organic bypass stream of an uranium laboratory extraction column. A combined photometric/electrolytical conductivity measurement allows this modified process instrument to be used as uranium/plutonium in-line monitor in radioactive process streams. By applying a high performance 100 W quartz halogen lamp and suitable light focussing optics the light intensity, attenuated by coupling losses, could be increased to the desired level even when 1000 μm-single strand fibers (2x18 m) were used to transmit the light. In a series of calibration experiments the U(VI)- and U(IV)-extinction coefficients were determined as a function of nitric acid molarity (for U(VI) also in TBP/kerosene). Furthermore the validity of Lambert-Beer's law was examined for both oxidation states at different optical path lengths and nitric acid/electrolytical conductivity calibration functions between 0-100 g/l U(VI) and 0-4 mol/l HNO_3 were set up. (orig./EF).

30108 (WSRC-RP–89-1359) **Process centrifuge operating problems and equipment failures in canyon reprocessing facilities at the Savannah River Site.** Durant, W.S.; Baughman, D.F. Westinghouse Savannah River Co., Aiken, SC (USA). Mar 1990. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90008219. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Laboratory (SRL) maintains a compilation of operating problems and equipment failures that have occurred in the fuel reprocessing areas of the Savannah River Site (SRS). At present, the data bank contains more than 230,000 entries ranging from minor equipment malfunctions to incidents with the potential for injury or contamination of personnel, or for economic loss. The data bank has been used extensively for a wide variety of purposes, such as failure analyses, trend analyses, and preparation of safety analyses. Typical of the data are problems associated with the canyon process centrifuges. This report contains a compilation of the centrifuge operating problems and equipment failures primarily as an aid to organizations with related equipment. Publication of these data was prompted by a number of requests for this information by other Department of Energy (DOE) sites. 11 refs., 2 figs., 4 tabs.

0509 Transport, Handling, and Storage

Refer also to citation(s) 30167, 30960

30109 (CEA-DAS–620) **Leaktightness definitions for and leakage tests on packages for the transport of radioactive materials.** Tanguy, L. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jul 1989. 4p. (CONF-890631–: International symposium on packaging and transportation of radioactive materials, Washington, DC (USA), 11-16 Jun 1989). Order Number DE90784658. Available from NTIS (US Sales Only), PC A02/MF A01.

In 1986, the International Organization for Standardization asked a group of experts representing some fifteen countries to draft a standard for the leaktightness of packagings used for the transport of radioactive materials. Progress of work and test before shipping of packages are reviewed.

30110 (CEA-DAS–623) **Experience gained from some incidents related to the shipment of radioactive materials.** Devillers, C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Aug 1989. 5p. (CONF-890631–: International symposium on packaging and transportation of radioactive materials, Washington, DC (USA), 11-16 Jun 1989). Order Number DE90784657. Available from NTIS (US Sales Only), PC A02/MF A01.

The number of accidents occurring during shipment of dangerous materials in France varies between 200 and 250 each year. Those concerning radioactive materials represent one or two events per year. Six incidents or accidents recorded these last few years have been selected as particularly significant; they include not only events on public highways but also events on nuclear sites relevant to transportation safety. These events are summarized together with corrective actions engaged after analysis of the causes of the events. Finally, more general conclusions drawn from these abnormal events are presented from the point of view of emergency preparedness.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30097

0520 Waste Management

Refer also to citation(s) 30106, 30162, 30164, 30165, 30166, 30168, 30170, 30369, 30485, 30844, 30884, 30913, 31350, 31468, 31472, 31669, 31671, 31672, 31673, 31674, 31995

30111 (AERE-R–13325) **The selectivity of zirconium phosphate for caesium in electrochemical ion exchange.** Lain, M.J. UKAEA Harwell Lab. (UK). Materials Development Div. Nov 1988. 33p. Order Number DE90627024. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The properties of amorphous zirconium phosphate are investigated as an inorganic ion exchanger for use in liquid waste treatment by electrochemical ion exchange. Experiments to determine and increase the selectivity for caesium exchange over sodium are discussed, including various pulsed waveforms and studies with rotating membranes. Automation of a sampling system with pH and atomic absorption measurements is described. (author).

30112 (AERE-R–13660) **The European Commissions Round Robin of their Repository System Simulation Test: A compilation and evaluation of the results for the granite option.** Marples, J.A.C. UKAEA Harwell Lab. (UK). Chemistry Div. Oct 1989. 104p. Contract 3/89 DR. Available from H.M. Stationery Office, London, price Pound 14.00.

A 'Round Robin' test of the European Commissions 'Repository Systems Simulation Test' has been undertaken by fifteen laboratories, ten of which did the granite option, six salt and three clay. The experiments involved testing an inactive simulant of the French high-level waste glass SON68 (R7T7) in containers which also held backfill, geological materials and water. The test procedure was closely specified by the Commission. Experiments with glass powder and (optionally) solid specimens in contact with aqueous solutions were run for periods of up to one year at 90^{0}C and the solutions were analysed for Si, B, Li and Mo (compulsory) and other constituents of the corroded glass (optional). The analytical results were used to calculate the Normalised Elemental Mass Losses (NEMLs) for various elements. This report compares and tabulates the results from the ten laboratories that undertook the granite option. The agreement between their results was only moderately good. The standard deviation of the NEMLs for B, Li, Mo and Cs, whose only source was the glass ranged from 20 to 60% of the mean. For other elements where the 'blank' concentrations were significant, the variation was greater. The NEMLs for the granite option were similar to, but slightly greater than those for the clay option but considerably less than those for the salt option. The NEMLs found after an MCC-1 test with de-ionised water were between 5 and 50 times greater. (author).

30113 (CNIC–00097) **Treatment of low level waste water by reverse osmosis.** Li Kaijun (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Zhang Chuanzhi; Xue Qinhua; Liu Meijun. China Nuclear Information Centre, Beijing, BJ (China). Nov 1987. 14p. (In Chinese). (IAE–0029). Order Number DE90627012. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Study on the removal of certain radioactive elements Such as ^{141}Ce, ^{51}Cr ^{134}Cu, ^{106}Ru and ^{131}I by Reverse Osmosis and the effect of surface activity agent on property of membrance are described in this paper. RO model is carried out to examine the treatment of actual reactor waste water and radioactive laundry waste water. The removal efficiency of total β is 98%. Three preprocessing (cloth pocket filtrator, hivefiltrator and zone) and membrane cleaning methods (acid, ozone and spongeball) are also investigated.

30114 (CNIC–00101) **Research of uranium tailing disposal by method of thickened disposal.** Dong Junkai (Ministry of Nuclear Industry, Beijing, BJ (China). Research Inst. of Uranium Ore Processing); Wang Zhizhang. China Nuclear Information Centre, Beijing, BJ (China). Dec 1988. 14p. (In Chinese). (BRIUOP–0003). Order Number DE90627026. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A basic principle of a thickened tailings disposal method is described and a main way of increasing tailing dam conditions, the non-selected density of the tailings in a mill, is determined. The followings are assayed: the slops of the tailing deposition, size composition and other main physical mechanical properties in the different positions of the deposition walls as well as the influence of lime and flocculant on various performances of the deposition walls. The basic regularities of deposition, consolidation, seepage, rheological properties and hydraulic transport, etc. are sought. A series of measurements about thickening of tailings slurry, hydraulic transport of heavy ore slurry, deposited dam, etc. are used in the old tailing pool of the mill to solve the problem influencing on safety in the mill are caused by the mill to solve the problem influencing on safety in the mill area caused by the seepage. The technological possibility and the economic reasonability of these measurements are described and the basic for design is provided. The results show that the transport of thickened tailings and deposition of tailing dam mentioned above have special advantages in saving energy, capital cost, decreasing occupied land and environment protection, ect. The suggested new method has a developing prospect in the uranium tailings disposal and a great value to use widely in non-ferrous ore processing plants.

30115 (CNIC–00167) **The behaviour of iodine in the process of evaporation and concentration of raffinate.** Luo Longjun (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Liu Zhimian; He Jianyu. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 6p. (In Chinese). (IAE–0040). Order Number DE90627013. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The behaviour of iodine in the process of evaporation and concentration of raffinate is studied. When the raffinate obtained from extraction of HNO_3-^{131}I solution with the 30% TBP-paraffin is evaporated and concentrated to 1/4.3 $\approx$ 1/9.1 in volume, the retained iodine in the distillate is smaller, and most of iodine goes to gas-off. The behaviour of iodine in the process of evaporation and concentration of raffinate obtained from extraction of HNO_3-^{131}I solution with irradiated (10^5 Gy) 30% TBP-paraffin is similar to that above mentioned. The effect of organic substances dissolved in raffinate on the removal of iodine from raffinate is smaller. Radioiodine is evaporated out easily while there is stable carrier of iodine in raffinate.

30116 (DOE/CH/10378–5) **RE/SPEC Inc. technical support to the Repository Technology Program: Technical progress report, September 19, 1988–September 30, 1989.** Coons, W.E.; Linde, K.M. RE/SPEC, Inc., Rapid City, SD (USA). 18 Mar 1990. 31p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC02-89CH10378. (RSI–0359). Order Number DE90009899. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report presents RE/SPEC Inc.'s technical support activities to the Repository Technology Program from September 19, 1988 through September 30, 1989. 10 refs., 1 tab.

30117 (DOE/OR/21548–120) **Buildings radiological characterization report for the Weldon Spring Site Remedial Action Project, Weldon Spring, Missouri.** MK-Ferguson Co., Weldon Spring, MO (USA); Jacobs Engineering Group, Inc., St. Charles, MO (USA). Apr 1990. 244p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-86OR21548. Order Number DE90010660. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

This report summarizes radiological characterization data on the Weldon Spring Chemical Plant (WSCP) buildings gathered as part of five previous investigations, and provides a consistent will be used to support future feasibility studies which will determine the best available technologies for ultimate disposition of the buildings and associated equipment. At present no structure or piece of equipment can be released from the WSCP for unrestricted use without further radiation measurements being performed. A final group of equipment and building components contains surface radioactivity levels in excess of DOE guidelines; this group, usually found in buildings housing uranium and/or thorium processing equipment, will require decontamination and comprehensive scanning in order to be considered for unrestricted use release. 9 refs., 44 tabs.

30118 (DOE/RL–89-28) **State Environmental Policy Act (SEPA) environmental checklist form for the closure of the 216-B-3 Pond System.** USDOE Richland Operations Office, WA (USA). 30 Mar 1990. 375p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90008223. Available from NTIS, PC A16/MF A01; OSTI; INIS; GPO Dep.

This document describes the activities for partial closure of the 216-B-3 Pond System operated by the US Department of Energy-Richland Operations Office and co-operated by the Westinghouse Hanford Company. The Hanford site has been divided into operable units to facilitate cleanup under CERCLA, the State of Washington Hazardous Waste Management Act of 1976, and RCRA corrective action provisions. An operable unit is a grouping of individual waste management units based primarily on geographic area, common waste sources, and similar geohydrologic properties. The Hanford Site waste management units have been categorized into past-practice units and TSD units. A past-practice unit is a waste management unit where waste has been disposed and is not subject to regulation as a TSD unit. All waste management units, including TSD units within an operable unit, generally will undergo investigation and remediation (closure) at the same time. 85 refs., 50 figs., 25 tabs.

30119 (DOE/RW–0262) **1989 OCRWM [Office of Civilian Radioactive Waste Management] Bulletin compilation and index.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (USA). Feb 1990. 75p. Sponsored by U.S. DOE Radioactive Waste Management. Available from OSTI; INIS.

The OCRWM Bulletin is published by the Department of Energy, Office of Civilian Radioactive Waste Management to provide current information about the national program for managing spent fuel and high-level radioactive waste. This document is a compilation of issues from the 1989 calendar year. A table of contents and one index have been provided to assist in finding information contained in this year's Bulletins. The pages have been numbered consecutively at the bottom for easy reference. 7 figs.

30120 (DOE/S–90010604) **Applied research, development, demonstration, testing and evaluation plan for environmental restoration and waste management.** USDOE, Washington, DC (USA). Nov 1989. 309p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010604. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This draft Department of Energy (DOE) Environmental Restoration and Waste Management Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) Plan is the first of many annual documents to delineate the current state of restoration and minimization technologies and to set milestones for research to fulfill DOE's objectives of reduced risk to human health and the environment, decreased cost, and a 30-year restoration goal. This Plan describes the initial makeup of the RDDT&E Program. The RDDT&E Program is necessary as part of the DOE commitment to (1) restore sites that have been impacted by mission activities related to weapons and energy research, and (2) upgrade future DOE waste management operations. To illustrate the typical logic of the RDDT&E Program, remediation of the Hanford single-shell tanks (SST) is summarized and linked to elements of the Plan.

30121 (DOE/WIPP–89-011-Rev.0) **WIPP [Waste Isolation Pilot Plant] test phase plan: Performance assessment: Revision 0.** USDOE Albuquerque Operations Office, Carlsbad, NM (USA). Waste Isolation Pilot Plant Project Office. Apr 1990. 246p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-86AL31950. Order Number DE90010531. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

The U.S. Department of Energy (DOE) is responsible for managing the disposition of transuranic (TRU) wastes resulting from nuclear weapons production activities of the United States. These wastes are currently stored nationwide at several of the DOE's waste generating/storage sites. The goal is to eliminate interim waste storage and achieve environmentally and institutionally acceptable permanent disposal of these TRU wastes. The Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico is being considered as a disposal facility for these TRU wastes. This document describes the first of the following two major programs planned for the Test Phase of WIPP: Performance Assessment – determination of the long-term performance of the WIPP disposal system in accordance with the requirements of the EPA Standard; and Operations Demonstration – evaluation of the safety and effectiveness of the DOE TRU waste management system's ability to emplace design throughput quantities of TRU waste in the WIPP underground facility. 120 refs., 19 figs., 8 tabs.

30122 (EPRI-NP–6808) **Proceedings: 1989 EPRI radwaste workshop.** Nelson, L. (Ascent Administrative Services, Boulder, CO (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Ascent Administrative Services, Boulder, CO (USA). c Apr 1990. 169p. Sponsored by Electric Power Research Institute. (CONF-8906318–: 11. EPRI radwaste workshop, Boulder, CO (USA), 26-28 Jun 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Electric Power Research Institute and the Radwaste Operations Subcommittee of the American society of mechanical Engineers annually sponsor a workshop in Low-Level Radioactive Waste Management. The workshop provides a forum for the exchange of practical operational experiences as they relate to radwaste management. As such, radwaste professionals offer their knowledge and expertise, making a valuable contribution to the quality and success of this workshop. The proceedings of the eleventh radwaste workshop, held June 1989, addressed the following pertinent issues: economics of waste; dry active waste; volume reduction; wet waste processing; and regulatory affairs. Highlights of the workshop included: the economic advantages of optimizing water and waste treatment; the state-of-the-art in DAW in-plant processing; the pros and cons of a mobile demineralizer system; and an update of current disposal site operations and regulations to name a few.

30123 (EUR–12077(1)) **Characterization of radioactive waste forms Volume 1: Progress report for 1987.** Brodersen, K. (Riso National Lab., Roskilde (DK)); Nilsson, K. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 206p. Available from NTIS (US Sales Only), PC A10/MF A01.

This document is the second yearbook for Task 3 of the European Communities 1985-89 programme of research on radioactive waste management and disposal carried out by public organizations and private firms in the Community through costsharing contracts with the Commission of the European Communities. The report, in two volumes, describes progress made in 1987 within the field of Task 3: Testing and evaluation of conditioned waste and engineered barriers. The first volume of the report covers Item 3.1 Characterization of low and medium-level radioactive waste forms and Item 3.5 Development of test methods for quality assurance. The second volume covers Item 3.2: High-level and alpha waste characterization and Item 3.3: Other engineered barriers. Item 3.4 on the round robin study will be treated in a separate report.

30124 (EUR–12077(2)) **Characterization of radioactive waste forms Volume 2: Progress report for 1987.** Smith, D.L. (Taywood Engineering Ltd., Winfrith (UK)); Green, T.H. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 217p. Available from NTIS (US Sales Only), PC A10/MF A01.

This document is the second yearbook for Task 3 of the European Communities 1985-89 programme of research on radioactive waste management and disposal carried out by public organizations and private firms in the Community through cost-sharing contracts with the Commission of the European Communities. The report, in two volumes, describes progress made in 1987 within the field of Task 3: Testing and evaluation of conditioned waste and engineered barriers. The first volume of the report covers Item 3.1 Characterization of low and medium level radioactive waste forms and Item 3.5. Development of test methods for quality assurance. The second volume covers Item 3.2: High-level and alpha waste characterization and Item 3.3: Other engineered barriers. Item 3.4 on the round robin study will be treated in a separate report.

30125 (EUR–12134) **Project COSA: Comparison of geomechanical computer codes for salt. Addendum to CASA I report.** Piper, D. (Atkis (W.S.) and Partners, Epsom (UK)); Lowe, M.J.S.;

Vouille, G. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 75p. Contract FL1W/0054/UK. Available from NTIS (US Sales Only), PC A04/MF A01.

Additional calculations and contributions to the first benchmark exercise of project COSA are presented. This report complements reference EUR 10760 on the same topic.

30126 (EUR–12141(1)) **The Community's research and development programme on radioactive waste management and storage. Shared cost action. Annual progress report 1988 Volume 1.** Commission of the European Communities, Luxembourg (Luxembourg). 1989. 421p. Available from NTIS (US Sales Only), PC A18/MF A01.

Third annual progress report of the European Community's 1985-89 programme of research and development on radioactive waste management and disposal, carried out by public organizations and private firms in the Community under cost-sharing contracts with the Commission of the European Communities. This report describes the work to be carried out under research contracts already concluded before the end of 1988, as well as the work performed and the results obtained so far.

30127 (EUR–12141(2)) **The Community's research and development programme on radioactive waste management and storage. Shared cost action. Annual progress report 1988 Volume 2.** Commission of the European Communities, Luxembourg (Luxembourg). 1989. 461p. Available from NTIS (US Sales Only), PC A20/MF A01.

Third annual progress report of the European Community's 1985-89 programme of research and development on radioactive waste management and disposal, carried out by public organizations and private firms in the Community under cost-sharing contracts with the Commission of the European Communities. This report describes the work to be carried out under research contracts already concluded before the end of 1988, as well as the work performed and the results obtained so far.

30128 (EUR–12226) **Calculation of groundwater flow and particle tracking for the Gorleben site with Metropol.** Leijnse, A. (Rijksinstituut voor Volksgezondheid en Milieuhygiene/LBG, Bilthoven (NL)); Glasbergen, P.; Nijhoff-Pan, I.; Sauter, F. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 75p. Contract FIW/0002-D. Available from NTIS (US Sales Only), PC A04/MF A01.

In the framework of the European Community Management and storage of radioactive waste programme and its Pagis project (Performance assessment of geological isolation systems), a study of the groundwater flow system in the permeable strata overlaying the Gorleben salt-dome in the Federal Republic of Germany has been carried out. The main purpose of this study was to compare the results obtained previously with the finite difference Swift computer code and the results obtained with the finite element Metropol computer code, developed at RIVM. Such a direct comparison was hampered by the fact that no standard is available for the results obtained. As a follow-up, Metropol was used for simulations that included the variations in the liquid density due to variations in the salt concentration. Some conclusions could be drawn: the travelling times of a particle through a single high permeable block increases by approximately two orders of magnitude compared to the constant density calculations due to the effect of high concentration gradients. However, the complexity of the problem considered has not yet made it possible to formulate conclusions for the complete model in a general way.

30129 (EUR–12237) **Chemval project report on stage 1: verification of speciation models: Topical report.** Read, D. (Atkins (W.S.) and Partners, Epsom (UK)); Broyd, T.W. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 364p. Contract F/1W/0077(UK). Available from NTIS (US Sales Only), PC A16/MF A01.

CHEMVAL is an international geochemical exercise, which aims at applicating and validating predictive computer programmes describing the chemistry of radionuclides in the geosphere. As a component of the CEC project MIRAGE- second phase (on migration of radionuclides in the geosphere), CHEMVAL is carried out in the framework of the third community R and D programme of radioactive waste management and storage. The present report is the first of a series devoted to the verification and validation of aqueous speciation and coupled chemical transport codes. Five cases systems are studied, namely, cement, clay, sandstore, granite and limestone. Overall, good agreement was obtained. Reasons for divergence in results have been explored and recommendations are made at the appropriate stages for enhancement of the thermodynamic data base. A listing of the preliminary CHEMVAL Project Data Base is provided.

30130 (EUR–12264) **Evaluation of the third community programme Radioactive waste management and storage (1985-1989).** Guillaumont, G.; Cottenie, A.; Harrisson, J.; Schmitt-Tegge, J.D.; Schuettenhelm, R.T.E.; Wright, J.K. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 95p. Available from NTIS (US Sales Only), PC A05/MF A01.

This evaluation report fits into the general framework of the Commission's evaluation policy (submitted in the form of a plan of action to the Council. O.J.C14 20.01.87). For the production of evaluation reports of Community research programmes, this plan envisages the use of independent external experts. The report consists of the following six chapters: - A general introduction covering the basis and procedure of the work, - An executive summary, available in each of the Community official languages, - A general review of the problems of radioactive waste, - The main reports, representing the actual evaluation of the programme, - The conclusion, which summarizes the main points, - Finally, policy action recommendations, followed by a recapitulation of the more specific recommendation from chapter IV and by a special note on the problem of public acceptance. At the end of the volume, annexes are added that provide the terms of reference given to the panel, list several more detailed documents which were used by the panel during the evaluation, and list people visited or interviewed by the evaluators.

30131 (GSF–18/89) **First geoelectric investigations within a sealing construction in the Asse.** Yaramanci, U.; Flach, D. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Braunschweig (Germany, F.R.). Inst. fuer Tieflagerung; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Sep 1989. 71p. (In German). Contract BMFT KWA 5603 6. (GSF-TL–26/89). Order Number DE90784904. Available from NTIS (US Sales Only), PC A04/MF A01.

Within a sealing construction project extensive geoelectrical DC-measurements have been carried out underground in the rock salt of the Asse. The investigations are already in progress before the building of the dam galleries and the dam itself and the insertion of brine, respectively. Thus they also serve as reference measurements for the variations of the conductivity structure of the investigated area during the different phases of the project. A fully automatic computer controlled measuring system has been developed and an extensive electrode network was installed in boreholes. Both the system and the netwerk have proved to be adequate. In principle and in practice the feasibility of the geoelectrical DC-method for both measurements in rock salt and for exploration has been indicated. On the average, the resistivity is 0.5 10^6 Ωm with relatively small variations of ±20%. In essence, the investigated area is homogeneous except for the local structure of a conductive inclusion, probably of a sulphate inclusion. (orig.).

30132 (IPEN-PUB–284) **Uranium conversion wastes.** Vicente, R.; Dellamano, J.C. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). Dec 1989. 40p. (In Portuguese). Order Number DE90627015. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A set of mathematical equations was developed and used to estimate the radiological significance of each radionuclide potentially present in the uranium refining industry effluents. The equations described the evolution in time of the radionuclides activities in the uranium fuel cycle, from mining and milling, through the yellow-cake, till the conversion effluents. Some radionuclides that are not usually monitored in conversion effluents (e.g. Pa-231 and Ac-227) were found to be potentially relevant from the radiological point of view in conversion facilities, and are certainly relevant in mining and milling industry, at least in a few waste streams. (author).

30133 (LA-UR-90-1251) **An in situ moisture monitoring system for a solid low-level radioactive disposal pit at Los Alamos National Laboratory, Technical Area 54, Area G.** Purtymun, W.F. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9004186–1: 4. national undergraduate resesearch conference, Schenectady, NY (USA), 19-21 Apr 1990). Order Number DE90010573. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

At the end of the 1950's, Los Alamos National Laboratory began to develop a Laboratory-wide, shallow-land, solid low-level radioactive waste disposal area on top of Mesita del Buey at TA-54, Area G. An in situ hydrologic monitoring system in the zone of aeration was developed in early 1990 to detect the presence of the infiltration of meteoric water into Pit 37 at Area G. Monitoring the water movement through the pit cap into the waste with leaching and transport the containment rock and possible contamination of the main aquifer is of primary concern. 2 refs., 1 fig.

30134 (LA-UR-90-1461) **^{36}Cl studies of water movements deep within unsaturated tuffs.** Norris, A.E. (Los Alamos National Lab., NM (USA)); Bentley, H.W.; Cheng, S.; Kubik, P.W.; Sharma, P.; Gove, H.E. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Radioactive Waste Management; National Science Foundation. DOE Contract W-7405-ENG-36. (CONF-900491–1: 5. international conference on accelerator mass spectroscopy, Paris (France), 23-27 Apr 1990). Order Number DE90010621. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Measurements of ^{36}Cl in cuttings from a borehole that was drilled 387 m into unsaturated tuffs indicate the possible detection of significant radioactive decay of cosmogenic ^{36}Cl in two of the samples. However, the ^{36}Cl/Cl ratio was found to vary with the amount of pulverization of the cuttings. Work is in progress to separate the ^{36}Cl/Cl data into cosmogenic and in situ components. The cosmogenic component will be used to trace very slow water movements through the unsaturated zone. Bomb pulse ^{36}Cl was observed as deep as 153 m, and this identification is not constrained by the problem with pulverization. This work shows the efficacy of ^{36}Cl measurements for detecting modern water movements deep in the unsaturated zone. 9 refs., 3 tabs.

30135 (NSS/R–155) **A laboratory study of gas transport through intact clay samples.** Lineham, T.R. UKAEA Harwell Lab. (UK). Chemistry Div. Apr 1989. 23p. Order Number DE90627027. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Measurements of the critical gas pressure of intact samples of Kimmeridge and London Clay along with measurements on London Clay of gas diffusion in solution were made in the laboratory. The critical gas pressure, the pressure required to overcome the capillary pressure in the pores of the samples, ranged from 3.5 to 6.2MPa. The intrinsic diffusion coefficients obtained for migration at low pressure in solution were of the order of 10^{-11} m^2s^{-1}. The samples were confined in test cells which simulated burial depths in excess of 200m and used nitrogen gas saturated with water. (author).

30136 (NSS/R–166) **Modelling saline intrusion for repository performance assessment.** Jackson, C.P. (UKAEA Harwell Lab. (UK). Theoretical Physics Div.); Farmer, C.L. United Kingdom Nirex Ltd., Harwell (UK). Apr 1989. 63p. Order Number DE90627028. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

UK Nirex Ltd are currently considering the possibility of disposal of radioactive waste by burial in deep underground repositories. The natural pathway for radionuclides from such a repository to return to Man's immediate environment (the biosphere) is via groundwater. Thus analyses of the groundwater flow in the neighbourhood of a possible repository, and consequent radionuclide transport form an important part of a performance assessment for a repository. Some of the areas in the UK that might be considered as possible locations for a repository are near the coast. If a repository is located in a coastal region seawater may intrude into the groundwater flow system. As seawater is denser than fresh water buoyancy forces acting on the intruding saline water may have significant effects on the groundwater flow system, and consequently on the time for radionuclides to return to the biosphere. Further, the chemistry of the repository near-field may be strongly influenced by the salinity of the groundwater. It is therefore important for Nirex to have a capability for reliably modelling saline intrusion to an appropriate degree of accuracy in order to make performance assessments for a repository in a coastal region. This report describes work undertaken in the Nirex Research programme to provide such a capability. (author).

30137 (NUREG/CR–1667) **Risk methodology for geologic disposal of radioactive waste: Scenario selection procedure.** Cranwell, R.M. (Sandia National Labs., Albuquerque, NM (USA)); Campbell, J.E.; Ortiz, N.R.; Guzowski, R.V. Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management; Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 107p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–80-1429). Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

This report contains the description of a procedure for selecting scenarios that are potentially important to the isolation of high-level radioactive wastes in deep geologic formations. In this report, the term scenario is used to represent a set of naturally occurring and/or human-induced conditions that represent realistic future states of the repository, geologic systems, and ground-water flow systems that might affect the release and transport of radionuclides from the repository to humans. The scenario selection procedure discussed in this report is demonstrated by applying it to the analysis of a hypothetical waste disposal site containing a bedded-salt formation as the host medium for the repository. A final set of 12 scenarios is selected for this site. 52 refs., 48 figs., 5 tabs.

30138 (NUREG/CR–5548) **Review of geochemical processes and codes for assessment of radionuclide migration potential at commercial LLW [low-level radioactive waste] sites.** Serne, R.J.; Arthur, R.C.; Krupka, K.M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management and Decommissioning; Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 129p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7285). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Available information concerning geochemical processes that control contaminant solution concentrations and migration at existing low- level radioactive waste (LLW) sites is reviewed. The purpose of the review was to identify the current status and future information needs required for the development of effective performance assessment models that will be used in support of future site license applications. Tritium appears to be the most mobile radionuclide that has been observed to migrate away from burial trenches at commercial LLW sites. Calculations of species distributions of contaminants are necessary to predict migration potential in groundwater systems. Further, speciation can only be reliably calculated from a combination of accurate chemical analyses and use of chemical reaction codes. Thus, the strengths and weaknesses of various reaction codes in describing chemical processes and the adequacy available data are reviewed. The review of geochemical processes identified microbial-degradation induced anoxia, subsequent iron oxide precipitation during oxidation, alkalinity controlled pH changes nd organic complexation reactions as key controls of radionuclide migration potential. Virtually all experimental work on radionuclide attenuation at commercial LLW site considers only adsorption. All data collected rely upon the empirical distribution coefficient concept. 276 refs., 4 figs., 13 tabs.

30139 (ORNL/FTR–3599) **[Low-level waste management programs]: Foreign trip report, April 20–May 1, 1990.** Daniel, E.W. Oak Ridge National Lab., TN (USA). 14 May 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90010813. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Traveler, along with R. C. Shilkett, Jr. of Idaho National Engineering Laboratory, met with Korea Atomic Energy Research Institute (KAERI) staff in accord with Korea/U.S. Joint Standing Committee on Nuclear and Other Energy Technologies (JSCNOET). Traveler presented a seminar on Low-Level Waste

Management Practices at Oak Ridge. The seminar, which emphasized the Department of Energy Model, was repeated at Korea Advanced Institute (KAIST) in Seoul. Visits were also made at Korea Electric Power Corporation (KEPCO) and Korea Power Engineering (KOPEC) offices in Seoul. 1 fig.

30140 (RCM–00989) **Investigations of aerosol formation in the HAW vitrification process.** Baumgaertner, F.; Heitz, J.; Krebs, K.; Petzoldt, O. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Oct 1989. 26p. (In German). Contract BMFT 02 U 5756/4. Order Number DE90785033. Available from NTIS (US Sales Only), PC A03/MF A01; With 4 refs., 1 tab., 18 figs.

Aerosol production during the vitrification process of high-level waste was simulated in a laboratory scale to increase the knowledge of the basic production mechanisms. Elemental composition, size distribution and production kinetics of the aerosols as well as the structure of individual particles were investigated. A comparison with the PAMELA vitrification plant was performed to check the validity of the results in a technical scale. (orig.).

30141 (SAND–88-7060) **Yucca Mountain Project: Preliminary shaft liner design criteria and methodology guide.** Richardson, A. (Parsons, Brinckerhoff, Quade and Douglas, Inc., San Francisco, CA (USA)). Sandia National Labs., Albuquerque, NM (USA); Parsons, Brinckerhoff, Quade and Douglas, Inc., San Francisco, CA (USA). Apr 1990. 203p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90010168. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

The Shaft Liner Design Criteria and Methodology Guide outlines a methodology for designing concrete shaft liners for the Yucca Mountain Project repository in tuff, the use of which will ensure that all shafts meet the requirements for repository service. These requirements are identified in the guide; then, unlined shaft behavior is examined to establish rock behavior modes and to investigate the development of convergence during construction. Ground pressure and induced thermal and seismic loads imposed on the shaft liner are evaluated. The modes of deformation resulting from loading, which include bending, shear, hoop deformation, and axial strain, are analyzed following a working stress approach that uses closed-form interaction models. Predicted liner stresses are then evaluated using allowable stress criteria. The methodology is illustrated with examples appropriate to the repository site at Yucca Mountain. 43 refs., 35 figs., 25 tabs.

30142 (SAND–89-0202) **Basic data report for drillholes H-14 and H-15 (Waste Isolation Pilot Plant-WIPP).** Mercer, J.W. (Sandia National Labs., Albuquerque, NM (USA)); Snyder, R.P. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 127p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008233. Available from NTIS, PC A06/MF A01 - OSTI.

Drillholes H-14 and H-15 were drilled to investigate data gaps in the hydrologic hole distribution at the WIPP site. In addition to the information gained on the Culebra Dolomite Member, the holes yielded hydraulic and/or stratigraphic information on the Forty-niner, Magenta Dolomite, and Tamarisk Members of the Rustler Formation in an era where no such information was available. Hydraulic tests were also conducted on the lower part of the Dewey Lake Redbeds in H-14. A suite of geophysical logs was run on the drillholes and was used to identify different lithologies and aided in the interpretation of the hydraulic tests. 3 refs., 4 figs., 6 tabs.

30143 (SAND–89-0203) **Basic data report for drillhole H-16 (Waste Isolation Pilot Plant-WIPP).** Mercer, J.W. (Sandia National Labs., Albuquerque, NM (USA)); Snyder, R.P. Sandia National Labs., Albuquerque, NM (USA). Jan 1990. 99p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. Order Number DE90008236. Available from NTIS, PC A05/MF A01; OSTI; INIS.

Drillhole H-16 is an exploratory test hole, 850.9 ft deep, drilled in eastern Eddy County, New Mexico, to study the hydrologic parameters of possible aquifers and how these aquifers could affect the construction and maintenance of a shaft to be located about 54 ft from the drillhole. This shaft will connect the underground working of the WIPP (Waste Isolation Pilot Plant) site to the surface. Geophysical logs were taken to measure acoustic velocities, density, radioactivity, porosity, and formation resistivities. This report describes the data collected during the drilling of exploration drillhole H-16. 2 refs., 2 figs., 3 tabs.

30144 (SAND–89-0204) **Basic data report for drillholes H-17 and H-18 (Waste Isolation Pilot Plant-WIPP).** Mercer, J.W. (Sandia National Labs., Albuquerque, NM (USA)); Snyder, R.P. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 183p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90008234. Available from NTIS, PC A09/MF A01 - OSTI.

Drillholes H-17 and H-18 were drilled at the WIPP site to assess uncertainties in site hydrologic parameters and to serve as monitoring points for planned hydrologic tests. H-17 was drilled south of H-11 and east of P-17 to evaluate the existence of a high-permeability region in the Culebra Dolomite Member that had been indicated by groundwater-flow modeling and surface geophysical surveys. H-18 was drilled north of H-2 to help reduce the uncertainties of boundaries between high and low transmissivities and fluid density that had been identified by drilling and by modeling. 1 ref., 4 figs., 6 tabs.

30145 (SAND–89-2030) **Parameter sensitivity studies of selected components of the Waste Isolation Pilot Plant repository/shaft system.** Rechard, R.P. (Sandia National Labs., Albuquerque, NM (USA)); Beyeler, W.; Schreiber, J.D.; McCurley, R.D.; Rudeen, D.K.; Bean, J.E. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 200p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010197. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This status report presents preliminary analyses of flow through the rooms, drifts, seals, and shafts of the Waste Isolation Pilot Plant (WIPP). The purpose of these analyses is to evaluate the importance of various components and parameters of the transuranic waste repository. These analyses are presented to show the current status of repository/shaft system modeling, and to provide input for evaluating proposed engineered modifications to the waste and rooms to ensure compliance with the Environmental Protection Agency's Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Waste. Detailed descriptions are given for nine computational models of the WIPP repository for either undisturbed or human intrusion conditions. Some models are refined versions of earlier models; others include rudimentary studies of an additional phenomenon, flow of generated gas. The models of an undisturbed repository substantiated the results of earlier models by showing that no waste leaves the vicinity of the disposal area in 10,000 yr. The models that studies gas flow agreed with this position; however, the models are too rudimentary to permit conclusive statements. The five models of the human intrusion event explored the importance of parameters that influence the flow of brine through the waste, establishing a base for understanding the behavior of the waste disposal rooms, drifts,and interbeds in the host rock. 63 refs., 92 figs., 29 tabs.

30146 (SAND–89-2671) **Overtest for Simulated Defense High-Level Waste (Room B): In situ data report (May 1984–February 1988): Waste Isolation Pilot Plant (WIPP) Thermal/Structural Interactions Program.** Munson, D.E. (Sandia National Labs., Albuquerque, NM (USA)); Jones, R.L.; Ball, J.R.; Clancy, R.M.; Hoag, D.L.; Petney, S.V. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 850p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010191. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

In 1981 the Waste Isolation Pilot Plant (WIPP) Project, under the direction of the US Department of Energy (DOE), began construction of a facility in southeastern New Mexico to develop the technology for disposing of radioactive waste from the defense programs. This facility may eventually become a repository for defense Transuranic (TRU) wastes, provided that the facility is demonstrated to be acceptable. Although the complete facility includes both surface and underground construction, the Repository

Isolation Systems Division of the Nuclear Waste Technology Department at Sandia National Laboratories (SNL) is primarily concerned with development of the underground portion of the facility; we focus on that portion of the facility in this report. This report is specific to the Thermal Structural Interactions (TSI) in situ tests of the Experimental Area and is one of a series intended to document the data obtained from the TSI in situ tests and to make these data available to potential users. 32 refs., 60 figs., 29 tabs.

30147 (SAND–89-3095) **Preliminary evaluation of potential engineered modifications for the Waste Isolation Pilot Plant (WIPP).** Butcher, B.M. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 74p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010165. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Analyses related to the Supplemental Environmental Impact Statement and preliminary performance assessment studies have suggested that alteration of the method of waste emplacement in the Waste Isolation Pilot Plant (WIPP) may be necessary in order to satisfy waste storage regulations. Good engineering practice also dictates consideration of changes which are useful for better containment of waste. This report presents a preliminary evaluation of various engineered modifications that might be considered. The report is based on work that has been ongoing at Sandia National Laboratories since FY88, before formation of the present Engineering Alternative Task Force by the Department of Energy WIPP Project Office. The engineered modifications under consideration are described and characterized in the first part of the report according to: the objective that would be addressed by their application; their level of complexity; and some of the presently understood limitations and uncertainties of their use. Results of studies conducted to date to examine the feasibility of some of the modification concepts are presented, with emphasis on the effects of waste "supercompaction." 21 refs., 14 figs., 5 tabs.

30148 (SKB-TR–89-05) **SKB WP-cave project. Transport of escaping radionuclides from the WP-cave repository to the biosphere.** Moreno, L. (Royal Inst. of Tech., Stockholm (Sweden)); Arve, S.; Neretnicks, I. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Jun 1989. 70p. Order Number DE90626603. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Far-field release rates for radionuclides that have escaped from the WP-cave repository (excluding the surrounding hydraulic cage) are calculated using the channeling model. The model considers flow in channels with different flowrates. The channeling model is based on the assumption that the channels are independent over a certain distance. In each channel the model takes into account the advective transport of the nuclide along a fracture with dispersion in the fracture and diffusion and sorption in the rock matrix. Preliminary calculations are performed to determine which parameters influence the release rate of the nuclides from the repository. These parameters are the travel length, channel width, and flowrate. The final results show that most of the radionuclides are not retarded to any great extent (if any) in the surrounding rock. The nuclides that are retarded in the rock are those that have a high sorption coefficient and/or short half-life. The calculations are performed for fractures that are 1 m in width, travel distrance of 100 m and a flowrate of 0.3 l/m^2a. (authors).

30149 (SKB-TR–89-21) **Rock quality designation of the hydraulic properties in the near field of a final repository for spent nuclear fuel.** Carlsson, Hans (Swedish Geological Co., Goeteborg (Sweden)); Carlsson, Leif; Pusch, Roland. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Jun 1989. 172p. Order Number DE90627029. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Quality assurance of a final repository for spent nuclear fuel requires detailed information on the characteristics of the rock, backfill, canisters and the waste itself. Furthermore, and of fundamental importance, is the knowledge of the behaviour of the integrated system of the waste and the different barriers. The in-situ characteristics of the rock must therefore be assessed and their influence on and interactions with the remaining barriers must be predicted and verified. A rock quality designation process of the hydraulic properties in the near-field is out-lined both for the KBS-3 system as well as for the WP-cave system. The process, once updated and approved, will be included in a Quality Assurance Program for the final repository for spent nuclear fuel. Some of the available methods for the near-field designation process are presented as well as techniques that need further development or are not developed at all. Finally, a presentation is given of a generic designation process of the KBS-3 and WP-cave repository systems in the previously investigated area in Central Sweden, where the final repository for reactor waste, SFR, is located. Geological and hydrogeological data are here at hand and it is therefore possible to carry out a simulation of how the designation process would be accomplished. (authors) (72 figs., 12 tabs., 43 refs.).

30150 (SKB-TR–89-23) **Deep ground water microbiology in Swedish granite rock and it's relevance for radio-nuclide migration from a Swedish high level nuclear waste repository.** Pedersen, Karsten (Goeteborg Univ. (Sweden). Dept. of Marine Microbiology). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Mar 1989. 21p. Order Number DE90627030. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Data on numbers, species and activity of deep ground water microbial populations in Swedish granite rock have been collected. Specific studies are performed on radio-nuclid uptake on bacteria judge to be probable inhabitants in Swedish nuclear waste repositories. An integrated mobile field laboratory was used for water sampling and for the immediate counting and inoculation of the samples from boreholes at levels between 129 and 860 m. A sampler adapted for the collection of undisturbed samples for gas analysis was used to collect samples for bacterial enumerations and enrichments. The sampler can be opened and closed from the surface at the actual sampling depth. The samples can subsequently be brought to the surface without contact with air and with the pressure at the actual sampling depth. The number of bacteria were determined in samples from the gas sampler when this was possible. Else numbers are determined in the water that is pumped up to the field lab. The average total number of bacteria is 3×10^5 bacterial ml^{-1}. The number of bacteria possible to recover with plate count arrays from 0.10 to 21.9%. (author).

30151 (SKB-TR–89-25) **Radionuclide sorption on crushed and intact granitic rock: Volume and surface effects.** Eriksen, Tryggve E. (Royal Inst. of Tech., Stockholm (Sweden). Dept. of Nuclear Chemistry); Locklund, Birgitta. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). May 1989. 46p. Order Number DE90627031. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The specific surface areas and distribution ratios for sorption of ^{85}Sr, ^{137}Cs and ^{152}Eu were measured for crushed and intact granite rock. The experimental data can be accommodated by a sorption model encompassing sorption on outer and inner surface. It is clearly demonstrated that the time required to obtain reliable Kd-values for the sorption of strongly sorbing radionuclides like ^{152}Eu is very long due to solution depletion and slow diffusion into the rock. A combination of surface area measurements and batch sorption with small particles may therefore be preferable when studying strongly sorbing nuclides. (authors) (17 figs., 6 tabs.).

30152 (SKB-TR–89-26) **Performance and safety analysis of WP-cave concept.** Skagius, K. (Kemakta Konsult AB, Stockholm (Sweden)); Svemar, C. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. 151p. Order Number DE90627032. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The report presents a performance safety, and cost analysis of the WP-cave, WPC, concept. In the performance analysis, questions specific to the WPC have been addressed which have been identified to require more detailed studies. Based on the outcome of this analysis, a safety analysis has been made which comprises of the modeling and calculation of radionuclide transport from the repository to the biosphere and the resulting dose exposure to man. The result of the safety analysis indicates that the present design of a WPC repository may give unacceptably high doses. By improving the properties of the bentonite/sand barrier such that the hydraulic conductivity is reduced, or by changing the short-lived steel canisters to more long-lived canisters, e.g. copper canisters,

it is judged possible to achieve a sufficiently low level of dose exposure rates to man. The cost for a WPC repository of the studied design is significantly higher than for a KBS-3 repository considering the Swedish conditions and the Swedish amount of spent fuel. The major costs are connected to the excavation and backfilling of the bentonite/sand barrier. The potential for cost savings is high but it is not judged possible to account for savings in such a way that the WPC concept shows lower cost than the KBS-3 concept. (34 figs., 33 tabs., 29 refs.).

30153 (SSI–89-13) **SFR-1, Environmental Impact.** Haegg, C.; Johansson, G. National Inst. of Radiation Protection, Stockholm (Sweden). 25 Aug 1989. 29p. Order Number DE90627033. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

SFR-1 is an underground disposal facility for low and intermediate level reactor waste. The present report considers the impact on the environment resulting from leakage of radionuclides from SFR-1. The radiation dose to a person in a hypothetical critical group has been estimated for two different situations: 1. the present day situation where the primary recipient is Oeregrundsgrepen with surroundings and 2. a situation when land uplift has altered the landscape to an inland area. The dominating dose pathways are for case 1. consumption of fish caught in Oeregrundsgrepen and for case 2. consumption of drinking water taken from a well drilled downstream the repository.

30154 (SSI–89-18) **Can the same principles be used for the management of radioactive and non-radioactive waste?.** Bengtsson, Gunnar. National Inst. of Radiation Protection, Stockholm (Sweden). 18 Sep 1989. 14p. Order Number DE90627065. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Non-radioactive waste has a much more complex composition than radioactive waste and appears in much larger quantities. The two types of waste have, however, some properties in common when it comes to their longterm impact on health and the environment. The occurrence in both of substances that may exist for generations and may cause cancer provides one example. Both types of waste also always occur together. It is therefore proposed that the same basic principles could be applied for the management of radioactive and non-radioactive waste. By doing so one may increase the efficiency of policy development, research and practical management. This is particurlarly importand for the very costly restoration of old disposal sites which have earlier been poorly managed. (author).

30155 (UCRL–21223) **Lawrence Livermore National Laboratory RCRA [Resource Conservation and Recovery Act] Part B health risk assessment: Phase 2, Hazardous waste management units.** Lawrence Livermore National Lab., CA (USA); Radian Corp., Sacramento, CA (USA). 20 Feb 1990. 173p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010752. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Lawrence Livermore National Laboratory (LLNL) operates several hazardous waste storage and treatment units for managing the wastes generated by research programs. As required by the California Hazardous Waste Control Act and the Resource Conservation and Recovery Act (RCRA), LLNL has applied for a Part B permit to continue operating their storage and waste treatment facilities. As part of this permitting process, LLNL is required to conduct a health risk assessment to examine the potential health impacts to the surrounding community from continued storage and treatment of hazardous and mixed radioactive wastes in the future. This document presents the results of the second phase of the risk assessment. An accident analysis for the maximum credible chemical accident is also included. 68 refs., 3 figs., 56 tabs.

30156 (UCRL–102285) **Selection criteria for container materials at the proposed Yucca Mountain high level nuclear waste repository.** Halsey, W.G. Lawrence Livermore National Lab., CA (USA). Nov 1989. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-900403–10: NACE Corrosion '90, Las Vegas, NV (USA), 23-27 Apr 1990). Order Number DE90010686. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A geological repository has been proposed for the permanent disposal of the nation's high level nuclear waste at Yucca Mountain in the Nevada desert. The containers for this waste must remain intact for the unprecedented service lifetime of 1000 years. A combination of engineering, regulatory, and licensing requirements complicate the container material selection. In parallel to gathering information regarding the Yucca Mountain service environment and material performance data, a set of selection criteria have been established which compare candidate materials to the performance requirements, and allow a quantitative comparison of candidates. These criteria assign relative weighting to varied topic areas such as mechanical properties, corrosion resistance, fabricability, and cost. Considering the long service life of the waste containers, it is not surprising that the corrosion behavior of the material is a dominant factor. 7 refs.

30157 (WHC-EP–0284) **Storage, treatment, and disposal alternatives for the 242-A Evaporator and PUREX [Plutonium-Uranium Extraction] Plant effluent.** Flyckt, D.L.; McCormack, R.L. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008207. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The 243-A Evaporator has been placed in temporary standby because of a concern that past practices may have made the evaporator process condensate a dangerous waste. In addition, an investigation of the Plutonium-Uranium Extraction (PUREX) Plant waste generation practices suggests that there is a potential for the PUREX Plant process condensate to be a dangerous waste. Operation of both the 242-A Evaporator and the PUREX Plant are vital to conducting the Hanford Site Environmental Restoration mission. Current mission plans cannot be supported if these facilities remain in a standby condition until currently planned treatment and disposal systems become operational. This report contains descriptions of current plans to provide alternative treatment and disposal systems for the process condensates, methods to accelerate the implementation schedule for the currently planned systems, and alternative systems that will replace the currently planned systems, or operate until the currently planned systems become operational. 6 refs., 3 figs., 10 tabs.

30158 (WINCO–1073) **Potential near-surface disposal concepts for high-level radioactive waste at the Idaho Chemical Processing Plant.** Chipman, N.A. Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (USA). Dec 1989. 52p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-84ID12435. Order Number DE90010187. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report presents concepts for on-site, near-surface disposal of high-level radioactive waste at the Idaho Chemical Processing Plant to be used as a basis for a no-action alternative for future environmental documentation. Near-surface disposal concepts described in this report include: in-place stabilization of the CSSF by filling the void space between the calcine and the concrete vaults with a non-swelling, highly impervious clay and sand mixture and covering the CSSF area with a multilayered berm of alluvium, clay, and riprap to isolate the area from potential flooding using state-of-the art designs and concepts, or immobilization and placement of the waste in an alternative location on the Idaho National Engineering Laboratory that would provide additional isolation. 50 refs., 15 figs., 1 tab.

30159 (WINCO–1074) **Leaching characteristics of Idaho Chemical Processing Plant calcines.** Chipman, N.A. Westinghouse Idaho Nuclear Co., Inc., Idaho Falls, ID (USA). Feb 1990. 42p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-84ID12435. Order Number DE90010202. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report documents leaching studies conducted on two non-radioactive, pilot-plant calcines produced at the Idaho Chemical Processing Plant. The two pilot-plant calcines simulate radioactive calcine which may be produced in the New Waste Calcining Facility by blending high-level liquid waste and sodium-bearing liquid waste. The calcines were subjected to the Environmental Protection Agency's Extraction Procedure Toxicity Test and to a test based on the Materials Characterization Center's MCC-1 Static Leach Test.

Following the protocol of these tests, leachates were obtained and analyzed for chemical composition to develop information about component mass loss and total mass loss. Surface analysis techniques were employed in an attempt to identify species that were leached from the calcines, but later precipitated during the MCC-1 tests. This report also documents leaching studies conducted on a radioactive fluorinel-sodium blend calcine produced in the New Waste Calcining Facility. This calcine was also subjected to a static leach test based on the MCC-1 test. The leachate was analyzed to develop information about total mass loss and leaching characteristics of radioactive species. 12 refs., 9 figs., 9 tabs.

30160 **Understanding radioactive waste.** Murray, R.L. (North Carolina Univ., NC (US)). 167p. Basil Blackwell Inc., New York, NY (USA) (1989).

This book discusses the sources and health effects of radioactive wastes. It reveals the techniques to concentrate and immobilize radioactivity and examines the merits of various disposal ideas. The book, which is designed for the lay reader, explains the basic science of atoms,nuclear particles,radioactivity, radiation and health effects.

0530 Environmental Aspects

Refer also to citation(s) 30145, 30155, 30160, 30164, 30462

30161 (SNV–3581) **The recipient control at Forsmark power station 1988.** Sandstroem, Olof (Statens Naturvaardsverk, Oeregrund (Sweden). Laboratoriet foer Miljoekontroll). Statens Natuurvaardsverk, Solna (Sweden). Feb 1989. 28p. (In Swedish). Order Number DE90626600. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A survey of the control activities at the Forsmark powerplant water recipient is presented. Net fishing was done in the Oeregrundsgrepen, at Finbo, Aaland and in the biotest lake. Fish diseases, bottom fauna and vegetation, nutrient salts and metal and radioecology were mapped out. (10 figs., 9 tabs., 10 refs.) (O.S.).

30162 **Protection of natural ecosystems: Impact of radiation from waste disposal practices.** Linsley, G. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Fuel Cycle and Waste Management). *International Atomic Energy Agency Bulletin (Austria),* 31(4): 28-31 (1989).

The prime concern in regulating activities involving the release of radioactive materials into the environment is ensuring the protection of human individuals and populations. It is assumed that if this is achieved then other non-human species will automatically be protected, although not necessarily individual members of those species. In almost all situations, the need to limit radiation doses to low levels is expected to ensure that radiation doses to other organisms will also be small and below the levels at which ecological changes could occur. These assumptions have not been seriously challenged in 30 years of nuclear power operations. Nevertheless, the issue is regularly discussed and recently it has been the subject of several review studies and assessments. In this review, three possible exposure scenarios (or cases) for man and for non-human organisms are considered.

0540 Health and Safety

Refer also to citation(s) 30108, 30118, 30120, 30155, 30160, 30173, 30343, 30422, 31578, 31579

30163 (CONF-900210–46) **Demonstration experience with an abrasive blasting technique for decontaminating concrete pads.** Devgun, J.S. (Argonne National Lab., IL (USA)); Land, R.R.; Doane, R.W. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990. Order Number DE90010082. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A demonstration was performed for decontaminating a radioactivity contaminated concrete pad with a portable abrasive blasting system. The system utilizes a rotating blast wheel that scours the concrete surface with metal abrasive. The metal abrasive, pulverized concrete dust, and contaminants rebound into a separator chamber. The reusable metal abrasive is recycled, and the pulverized media are removed to an integral dust collection system. The exhaust is HEPA filtered to minimize release of airborne contaminants. However, the technique had limited success in reducing contamination around the cracks and seams in the concrete where the higher activity levels of contamination were detected during the radiological survey before the cleanup. The technique can be successful and cost-effective in decontaminating large areas of low contamination; however, careful characterization and planning are necessary. 3 refs., 3 figs., 1 tabs.

30164 (CONF-9004181–1) **Radiological risk assessment for radioactive contamination at landfill site.** Devgun, J.S. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From DOE Remedial Action Program conference; Albuquerque, NM (USA); 16-19 Apr 1990. Order Number DE90010061. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A limited-scope preliminary assessment of radiological risk has been conducted for a landfill site where radioactive residues resulting from past uranium ore processing operations are present. Potential radiation doses to an individual under different scenarios have been predicted using the RESRAD computer code. The assessment provides useful input to the remedial action planning for the site that is currently underway. 7 refs., 6 figs., 3 tabs.

30165 (SKB-TR–89-06) **Individual radiation doses from nuclides contained in a WP-cave repository for spent fuel.** Bergstroem, U. (Studsvik Nuclear, Nykoeping (Sweden)); Nordlinder, S. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden); Studsvik Nuclear, Nykoeping (Sweden). Jul 1989. 88p. (STUDSVIK-NP–89-36). Order Number DE90626604. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The individual radiation doses to man were calculated from leakage of radionuclides from a WP-cave repository for spent nuclear fuel. This study is a part of a safety analysis of a WP-cave repository performed by SKB. It was assumed that the nuclides reach the biosphere by inflow to a well and/or a lake. Therefore calculations were performed for three different critical groups. The turnover in the biosphere and the exposure to man was modelled by a compartment model using the BIOPATH-code. The nuclides dominating the total dose were identified. These were C-14, Se-79, Sn-126, I-129, Pa-231, Th-229 and Np-237. Maximum doses were about 3E-6 Sv/year. Uncertainty analysis was carried out using the PRISM-code for the dose dominant nuclides. For all nuclides and cases the ranges of the doses are within three orders of magnitude for 90% confidence interval. The main parameters to the uncertainty in the case with outflow to a well are the volume of the well, the amount of water consumed or the migration in the soil. For the lake case major contributions to the uncertainty arise from the sedimentation, bioaccumulation in fish and the amount of consumption of fish. (authors) (33 refs.).

30166 (SSI–89-14) **Radiation protection criteria in the long-range view.** Snihs, J.O.; Bergman, C. National Inst. of Radiation Protection, Stockholm (Sweden). 1 Sep 1989. 14p. (In Swedish). Order Number DE90626591. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The report presents by way of introduction radiation protection criteria applied to radiological activities and to disposal of low-level and intermediate-level radioactive waste. In these cases it is primarily short-range views that are relevant, up to a few thousand years as a maximum. In the case of high-level wastes where the views may extend to more than hundreds of thousands years, there are not for the present any equally well stablished criteria. Based upon preliminary results from a Nordic team for criteria for high-level radioactive wastes, dose estimates in the long-range view and alternative assessment criteria are discussed. Proposals are also presented for 12 criteria that may be applicable. As the work is not yet finshed, the criteria are however merely preliminary.

30167 (SSI–89-20) **Estimates of health risks associated with uranium transportation by air.** Elert, M. (Kemakta Konsult AB, Stockholm (Sweden)); Skagius, K.; Ericsson, A.M.; Karlsson,

L.G.; Markstroem, A. National Inst. of Radiation Protection, Stockholm (Sweden). 26 Oct 1989. 175p. Order Number DE90626605. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

There is today an increased interest for air transport of large quantities of uranium compounds. In this report the health risks from an aircrash where uraniumhexafluoride, uraniumdioxide powder, low enriched unirradiated fuel used in Swedish power reactors and unirradiated MTR-fuel used in the research reactor in Studsvik, is analysed. The radiation doses to personnel and the general public is calculated as well as the ground contamination from the spreaded material. Also air concentration of hydrogenflouride, from uraniumhexaflouride reacting with moisture in the air, is calculated. A number of intermediate results are presented. (authors) (69 refs.).

30168 (UCID–21900) **Analysis of a postulated radiological accident from mixed waste operations at existing hazardous waste management facilities at the Lawrence Livermore National Laboratory.** Salazar, R.J.; Mecozzi, J.M.; Taie, M.N. Lawrence Livermore National Lab., CA (USA). Feb 1990. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008244. Available from NTIS, PC A03/MF A01 - OSTI.

The existing Hazardous Waste Management Facilities (HWMF) which are located at the southeast corner of Lawrence Livermore National Laboratory (LLNL) store, treat and prepare for disposal hazardous, mixed and radioactive wastes generated by the programmatic activities at the Laboratory. Accidents during the facility operations can be postulated that potentially could affect individuals and populations outside the HWMF. This report evaluates impacts from the maximum credible accident that might result from mixed waste operations at the HWMF units requiring a RCRA and California Hazardous Waste Control Act Part B permit. This postulated accident was considered for the purpose of evaluating maximum potential consequences and to determine if an accidental release of radionuclides would result in unacceptable doses to on-site workers and the public. In determining a maximum credible accident, primary consideration was given to the postulated situations potentially having the greatest health impacts to the public. The health risk assessment evaluates releases during normal operations. 21 refs., 2 figs., 4 tabs.

30169 Population exposures from US Department of Energy Operations. Welty, C.G. Jr. (Dept. of Energy, Washington, DC (USA)); Kennedy, W.E. Jr.; Hawley, K.A. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC06-76RL01830. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

It is the U.S. Department of Energy's (DOE) policy to conduct its nuclear operations in a manner consistent with national environmental policy and in conformance with applicable environmental policy and in conformance with applicable environmental standards and regulations. This policy is implemented by the DOE Orders and environmental protection programs that control releases of radioactive materials to the environment and limit the potential magnitudes of public doses. The operating contractors at DOE nuclear sites provide annual summaries, while DOE management provides program requirements and overviews to ensure that the releases and resultant public doses are maintained as low as reasonably achievable. Control of radioactive effluents from DOE facilities during the last several years has been adequate to meet DOE public radiation standards. Population exposures, although they have fluctuated, have recently trended downward, reflecting continued vigilance on the part of DOE and its contractors.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 30105, 30177, 30419

30170 (LA-UR–90-1303) **Neutron-chamber detectors and applications.** Fehlau, P.E.; Atwater, H.F.; Coop, K.L. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900563–3: 7. symposium on radiation measurements and applications, Ann Arbor, MI (USA), 21-24 May 1990). Order Number DE90010586. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Detector applications in Nuclear Safeguards and Waste Management have included measuring neutrons from fission and (alpha,n) reactions with well-moderated neutron proportional counters, often embedded in a slab of polyethylene. Other less-moderated geometries are useful for detecting both bare and moderated fission-source neutrons with good efficiency. The neutron chamber is an undermoderated detector design comprising a large, hollow, polyethylene-walled chamber containing one or more proportional counters. Neutron-chamber detectors are relatively inexpensive; can have large apertures, usually through a thin chamber wall; and offer very good detection efficiency per dollar. Neutron-chamber detectors have also been used for monitoring vehicles and for assaying large crates of transuranic waste. Our Monte Carlo calculations for a new application (monitoring low-density waste for concealed plutonium) illustrate the advantages of the hollow-chamber design for detecting moderated fission sources. 9 refs., 6 figs., 2 tabs.

30171 (NUREG–0430-Vol.9-No.2) **Licensed fuel facility status report: Inventory difference data, July 1, 1988–June 30, 1989.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards. Apr 1990. 16p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

NRC is committed to the periodic publication of licensed fuel facilities inventory difference data, following agency review of the information and completion of any related NRC investigations. Information in this report includes inventory difference data for active fuel fabrication facilities possessing more than one effective kilogram of high enriched uranium, low enriched uranium, plutonium, or uranium-233.

30172 (NUREG–1404) **Licensee use of tactical exercise results.** Sawyer, C.; Brown, C. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safeguards and Transportation. Apr 1990. 6p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

On November 10, 1988 the Nuclear Regulatory Commission (NRC) amended its physical security requirements in 10 CFR Part 73 for fuel facilities possessing formula quantities of strategic special nuclear material. The amendments to 10 CFR 73.46(b) require, among other things, that licensees carry out performance evaluations through tactical response exercises. The exercises are intended to demonstrate the guard force state of readiness and to test the effectiveness of delay mechanisms, alarm and communication systems, response times, deployment of response forces, firing skills (simulated), tactical maneuvers, etc. The purpose of this document is to set forth criteria, acceptable to the NRC staff, which will enable a licensee to use the results of an exercise to determine whether additional training or security improvements are needed.

30173 (WHC-EP–0319) **Hazardous Materials Management and Emergency Response (HAMMER) Training Center feasibility study: Final report.** Curry, R.H. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 141p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90010160. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This document reports the results of a feasibility study for a Hazardous Materials Management and Emergency response Training Center. The study responded to a proposal for such a training center at the US Department of Energy's Hanford Site in southeast Washington State. That proposal addressed a special need created by federal laws that require specific training for persons who respond to incidents involving hazardous materials. The study showed that this type of training center is indeed feasible. Such a project would benefit the Hanford Site, the Department of Energy, and local public entities. Further, this training center concept fits well with existing Hanford Site missions and capabilities. 8 refs., 7 figs., 5 tabs.

0560 Legislation and Regulations

Refer also to citation(s) 30122, 30342

30174 (CEA-DAS–621) **Is not the universality of implementation of IAEA rules as difficult to maintain as it was to obtain.** Grenier, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Jul 1989. 6p. (CONF-890631–: International symposium on packaging and transportation of radioactive materials, Washington, DC (USA), 11-16 Jun 1989). Order Number DE90784653. Available from NTIS (US Sales Only), PC A02/MF A01.

IAEA recommendations on the safe transport of radioactive materials succeded in their task to uniformize the applicable rules for national and international transport. Problems set up by this carriage evolve with technical progress, nuclear knowledge and implementation development. This report tries to see under what conditions, the harmony obtained at one given date could be maintained and kept with the passing time, through the necessary adaptations in the field of the making up of the general rules, and in the practical applications.

30175 (CEA-DAS–624) **A regulatory approach to the safe transport of plutonium by air.** Devillers, C. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (FR). Dept. d'Analyse de Surete); Ringot, C.; Tomachewsky, E.G.; Hubert, P.; Pages, P. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. 1989. 11p. (CONF-890631–: International symposium on packaging and transportation of radioactive materials, Washington, DC (USA), 11-16 Jun 1989). Order Number DE90784656. Available from NTIS (US Sales Only), PC A03/MF A01.

The main objective of a modification of AIEA safety standards is to limit the radiological consequences of accidents involving airplanes carrying radioactive packages with a high level of potential danger, priority being placed on packages containing plutonium. The second objective is to facilitate emergency planning and package recovery. These objectives can be met through an appropriate upgrading of package designs with respect to additional requirements relevant to air transport accident conditions including specific mechanical and thermal tests. These requirements can be formulated in terms of: amount of radioactive material above which an upgraded package shall be used, additional tests and acceptance criteria for the qualification of upgraded packages. A review of relevant safety objectives: protection of the public, protection of the environment, and protection of surviving persons has been made.

30176 (IAEA-INFCIRC–209(Mod.4)) **Communications received from Members regarding the export of nuclear material and of certain categories of equipment and other material.** International Atomic Energy Agency, Vienna (Austria). Feb 1990. 4p. Order Number DE90627086. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Hard copies are available in English and Russian from IAEA Division of Publications, Distribution Unit.

The document reproduces the text of the letters and their annex dated 1 December 1989 received by the Director General of the IAEA from the Resident Representatives to the Agency of the following Member States: Australia, Canada, Czechoslovakia, Finland, the German Democratic Republic, Greece, Hungary, Japan, the Netherlands, Norway, Sweden, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland and the United States of America concerning the commitments of these Member States under Article III paragraph 2, of the Treaty on the Non-Proliferation of Nuclear Weapons. It refers to the export of the equipment especially designed or prepared for the separation of isotopes of uranium.

30177 (IAEA-INFCIRC–374) **Agreement of 11 October 1989 between the International Atomic Energy Agency and the Government of India for the application of safeguards in connection with the supply of nuclear material from France.** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 11p. Order Number DE90627114. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The text of the Agreement of 11 October 1989 between the Government of India and the Agency for the application of safeguards in connection with the supply of nuclear material from France, which was approved by the Board on 20 September 1989, is reproduced in this document.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0702 Radiation Sources

Refer also to citation(s) 30182, 31109

30178 (CNIC–00284) **Application of radioisotope tracing technique in the agricultural machinery research.** Wang Shuyu (Northeast College of Agriculture, Harbin, HL (China)); Wang Chengzhi; Hao Xinliang; An Yilu; Li Jinghui; Cui Zaijiu; Liu Dashen; Zhang Peng. China Nuclear Information Centre, Beijing, BJ (China). Oct 1988. 17p. (In Chinese). (U08-NAC–0024). Order Number DE90626735. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The radioisotope tracing technique with ^{60}Co and ^{3}H radionuclides was used in the process of shelling, clearing and drying when agricultural machines were utilized. The velocity distribution and travelling time of cereal from inlet to the outlet in the axial-flow threshing cylinder were measured. The dropping and moving velocity on the reciprocating sieve were determined. The effect of heating-drying on the wet cereal which were mixed with dry cereal was studied. The experimental data obtained is useful for improving the functions of shelling, clearing and drying machines as well as the reduction of energy consumption.

30179 (CTA-IEAv-NT–016/81) **Neutron production in thick targets by electrons of energy from 30 to 200 MeV.** Goncalez, O.L. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. 2 Sep 1981. 15p. (In Portuguese). Order Number DE90626686. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The efficiency of neutron production by electron incidence from 30 to 200 MeV on thick metalic targets of Al, Sb, Cu, Ir, Hg, Mo, Nb, Ni, Pd, Pt, Ta, Ti, W and Zr is evaluated. The analitical calculation is based on photon track length expression from cosmic-ray theory. Correction factors based on bremsstrahlung efficiency and on numerical calculations are also introduced. This analysis is useful to qualify materials avaliable to be used as neutron sources on electron linear accelerators. The results agree with experimental data with an accuracy better than 10%. (author).

30180 **A 30 MeV H^- cyclotron for isotope production.** Baartman, R. (TRIUMF, Vancouver (Canada)); Kleevan, W.J.; Laxdal, R.E.; Milton, B.F.; Otter, A.J.; Pearson, J.B.; Poirier, R.L.; Schmor, P.W.; Schneider, H.R.; Erdman, K.L. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Because of an expanding market for radioisotopes there is a need for a new generation of cyclotrons designed specifically for this purpose. We describe such a cyclotron currently under construction. It is a 30 MeV H^- design that exploits a newly developed high brightness multicusp ion source which is capable of H^- currents of up to 5 mA. This together with careful beam matching then makes feasible accelerated H^- beam intensities of 500 μA. The cyclotron being built is a four sector radial ridge design with two 45° dees in opposite valleys. Beam extraction is by stripping to H^+ in a thin graphite foil. Two extraction probes will allow simultaneous extraction of two beams, each with an intensity of up to 200 μA. Energy variation from 15 MeV to 30 MeV is achieved by varying the radial position of the extraction foil. 7 refs., 4 figs., 1 tab.

30181 **Long life x-ray source target.** Forsyth, J.M.; Frankel, R.D. To Hampshire Instruments, Inc., Rochester, NY. USA Patent

4896341/A/. 23 Jan 1990. Filed date 13 Oct 1987. USA Patent Application 7 107,961–. Int. Cl. G21K 5/00. vp.

The patent describes an improvement in an X-ray lithography system including means for providing an excitation beam pulse along a path toward a target to cause an X-ray emitting plasma to be formed and means for moving an X-ray resist coated object to be irradiated by the emitted X-rays. The improvement comprising: target means, including a feeding reel, a take-up reel and a target material tape therebetween and positioned in the path of the beam; and means for moving the target tape from the feeding reel towards the take-up reel between the provisions of selected pulses. The tape having at least one cavity thereon and the beam intersecting the cavity. The beam being of sufficient power to cause an x-ray emitting plasma to be created at least partially within the cavity.

0704 Economic, Industrial, and Business Aspects

30182 (MLM–3632) **Stable isotope sales: Mound customer and shipment summaries, FY 1988.** Flayler, K.A. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 23 Apr 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90008229. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report lists Mound's sales of stable isotopes of noble gases, carbon, oxygen, nitrogen, chlorine, bromine, and sulfur for fiscal year 1988. Purchasers are listed alphabetically and are divided into domestic and foreign groups. Cross-reference indexes by location and by isotope purchases are included for all customers. 3 tabs.

0705 Health and Safety

30183 (NUREG–1405) **Inadvertent shipment of a radiographic source from Korea to Amersham Corporation, Burlington, Massachusetts.** Nuclear Regulatory Commission, Washington, DC (USA). May 1990. 161p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

Amersham Corporation, Burlington, Massachusetts, a licensee of the US Nuclear Regulatory Commission (NRC), authorized to manufacture and distribute iridium-192 and cobalt-60 source assemblies for use in radiography equipment, received a shipment of 14 source changer son March 8, 1990, that were being returned from their product distributor, NDI Corporation in Seoul, Korea. One source changer contained a small sealed source in an unshielded location. Amersham employees retrieved the source, secured it in a hot cell, and notified NRC's Region I. Subsequently, NRC dispatched an Incident Investigation Team to perform a comprehensive review of this incident and determine the potential for exposure to those who handled the source changer and to members of the general public. This report describes the incident and the methodology used in the investigation and presents the Team's findings and conclusions.

08 HYDROGEN

Refer also to citation(s) 31744

0830 Combustion

Refer also to citation(s) 30635, 30946, 30948

30184 (PB–90-861980/XAB) **Hydrogen use as a fuel. April 1972-January 1990 (a Bibliography from the NTIS data base). Report for April 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 119p. Available from NTISPC N01/MF N01.

Supersedes PB–89-857023.

This bibliography contains citations concerning the use of hydrogen as a fuel in vehicular transportation, electric power generation, and both subsonic and supersonic aircraft. Feasibility studies, engine performance evaluations, and combustion properties are discussed. Citations pertaining specifically to hydrogen production and storage are excluded. (This updated bibliography contains 234 citations, 13 of which are new entries to the previous edition.)

30185 Chemical models for pdf modeling of hydrogen-air nonpremixed turbulent flames–. Chen, J.-Y. (Sandia National Labs., Livermore, CA (USA). Combustion Research Facility); Kollmann, W. *Combustion and Flame (USA),* 79(1): 75-99 (Jan 1990).

Development of simplified chemical models is necessary for probability density function (pdf) modeling of turbulent flames with multiple species. Two promising approaches, the reduced mechanism method and the constrained equilibrium method, have been extensively studied to develop six plausible chemical models for nonpremixed combustion of hydrogen with air. Examination of the thermodynamic properties predicted by the chemical models in the allowable domains reveals that in regions where temperatures are above 1400 K, all six models yield similar results. In regions near the pure mixing limits, the partial equilibrium assumption for bimolecular reactions breaks down and yields unrealistic results. Reasonable agreement between the measured temperatures and those from Monte Carlo simulations with all six chemical models has been obtained for a nonpremixed turbulent jet flame at low mixing rates. As mixing rate increases, flame blowout has been predicted only by a chemical model that treats the hydrogen atom H by its kinetics rate equation, which is based on the reduced mechanism method. The predicted jet velocity at flame blowout is much higher than that observed in experiments. One of the implications from the present results is the need for improved submodels for mixing processes.

09 BIOMASS FUELS

Refer also to citation(s) 30488

0907 Resources

30186 (DOE/CH/10093–69) **Biofuels program summary: Volume 2, Research summaries, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 240p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009484. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The federal government has supported research on biomass technology and energy from municipal waste since 1975. Separate research programs were conducted until 1985 when the two were merged into biofuels and municipal waste technology to take advantage of their many similarities in conversion requirements and research needs. The purpose of the biofuels program is to provide focus, direction, coordination, and funding for the development of technologies that produce tailored energy crops and convert these crops and wastes to fuels. The FY 1989 program includes research on the production (growth) of biomass and its conversion to fuels. Research on biomass production involves the development and use of genetically improved trees and grasses specifically for their energy conversion characteristics (terrestrial energy crops). The Biofuels Program Summary is prepared each year and consists of a two-volume reference set describing the technological advances, current projects, and future research and development (R&D) directions of the program. Volume 1 (Overview) contains a brief history of the program and summary descriptions of research activities and significant accomplishments during the year. It also provides information on the management structure and budget of the program. This volume (Volume 2-Research Summaries) is a compilation of detailed descriptions of the R&D projects performed by the national laboratories and their subcontractors from industry, universities, and nonprofit research institutions. It is divided into an introduction and three sections. 358 refs.

30187 (YEDT–CE02912, pp. 271-284) **Management of forests in interior Alaska.** Zasada, J.C. (Inst. of Northern Forestry, U.S. Forest Service, Fairbanks, AK (USA)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources

Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The purpose of this paper is to describe the recent forest management situation in interior Alaska, particularly the Tanana Valley, as well as to consider past practices and what might occur in the future. In addition, because the level or intensity of forest management is determined by factors other than biological considerations including forest utilization, economics and government regulations, brief consideration is given to these variables as they relate to interior Alaska. The review is made chiefly from the point of view of timber management.

30188 (YEDT–CE02912, pp. 287-299) **Resource policy impacts on forest management: Fire management and land disposal in the Tanana River Basin, Alaska.** Welbourne, M.L. (Div. of Research and Development, Dept. of Natural Resources, Anchorage, AK (USA)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The use of ecosystem processes to predict long term ecosystem changes, and the use of basic ecological units as the foundation for impact evaluation, are fundamental to ecologically based policy analysis. A case study is presented here in which the impacts on forest resources of state policies for fire management and land disposals are assessed over 21 million acres in the Tanana River Basin. Forest succession patterns are used to predict long term changes in a dynamic forest ecosystem. Changes in abundance of vegetation are interpreted for their impact on net forest productivity, availability of wood products, the amount of land available for sustained yield management, and the ability of the State of Alaska to meet its objectives for these parameters. The range of policies that affect forest management extends well beyond those intended to direct timber production. Analyses of the fire management and land disposal policies in the Tanana River Basin demonstrate the need to evaluate the long term effects of such policies on ecosystem processes. Understanding these effects provides the basis for designing policies that complement forest management programs. 8 refs., 4 figs.

0908 Production

Refer also to citation(s) 30207

30189 (PB–90-172164/XAB) **Bioenergy systems report: The AID (Agency for International Development) approach. Using agricultural and forestry wastes for the production of energy in support of rural development.** Agency for International Development, Washington, DC (USA). Office of Energy. Apr 1989. 54p. Available from NTIS, PC A04/MF A01.

The Biomass Energy Systems and Technology project (BEST) seeks to integrate natural resources, private sector expertise, and financial support in order to convert biomass into marketable energy products at existing agro-processing facilities. This report documents BEST's approach to biomass promotion and includes sections on: the rationale for the project's commodity focus (sugar cane, rice, and wood); the relevant U.S. biomass experience with rice, cane, and wood residues, etc., which BEST draws upon; A.I.D.'s experience in the field application of rice, wood, and cane residue bioenergy systems; economic analyses of biomass systems (using examples from Indonesia and Costa Rica); research initiatives to develop off-season fuels for sugar mills, advanced biomass conversion systems, and energy efficiency in sugar factories; and the environmental aspects of biomass (including its ability to be used without increasing global warming).

30190 (PB–90-178484/XAB) **Studies on the production of biogas. Master's thesis.** Khatoon, S. Centre of Excellence in Physical Chemistry, Peshawar (Pakistan). 1981. 130p. Available from NTIS, PC A07/MF A01.

The influence of temperature, and dilution of the bio-waste (Buffalo dung) on the production of bio-gas has been investigated, chromatographically. The results obtained show that at 1:1 water dung ratio and keeping the temperature of 35C, the volume of the gas evolved is maximum with approximately 76% of methane content. The remaining slurry was analyzed and it showed the promise of being a good manure.

30191 (YEDT–CE02912, pp. 353-268) **Energy from the forests of Canada.** Dobbs, R.C. (Canadian Forestry Service, Ottawa, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper provides a review of Canada's Energy from the Forest (ENFOR) program. Canada is a forested nation and the world's foremost consumers of energy. Forest biomass now provides about 4 percent of the nation's energy budget, and it has the potential of providing a considerably greater portion. However, there are some formidable obstacles. In order to overcome these obstacles, new knowledge, methods, practices, machines and systems are required, and public awareness of opportunities must increase. To provide these requirements, in 1978 the federal government launched the ENFOR program. ENFOR is a contract R&D program comprising biomass production and biomass conversion components. The production component is concerned with raw material supply, and thus with forest-oriented matters such as inventory, harvesting, environmental impacts and silviculture. The conversion component deals with the transformation of delivered biomass to energy, prepared fuels and energy-intensive chemicals. The production component is administered by the Canadian Forestry Service (CFS), and is the principal concern of this paper. The conversion component is administered by the renewable Energy Division of Energy, Mines and Resources Canada. It addresses four problem areas: biomass availability, biomass harvesting, environmental impacts, and intensive silviculture. 9 refs., 2 figs., 4 tabs.

30192 (YEDT–CE02912, pp. 301-317) **Potential effects of short rotation forestry in high latitudes on soils and site fertility.** Yarie, J. (Forest Soils Lab., Univ. of Alaska, Fairbanks, AK (USA)); Van Cleve, K. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The current forest harvesting literature describes most of the potential physical effects. If road building and harvesting techniques are matched to the site there should be little problem with adverse physical effects. The one factor found in northern latitudes which will require special attention is permafrost. Site fertility effects have to be evaluated on a site specific basis. To avoid large, detailed studies of nutrient cycles on a site specific basis it is best to adopt a general model and calibrate for specific sites. By using a model as a starting point it should be possible to accomplish three tasks: identify research needs, establish the priority of these research needs and identify sites which may be most sensitive or provide the greatest return to intensified management. 18 refs., 4 tabs.

30193 (YEDT–CE02912, pp. 319-330) **Forest biomass energy production for the North.** Zsuffa, L. (Ontario Tree Improvement and Forest Biomass Inst., Ontario Ministry of Natural Resources, Maple, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from

CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Only a small portion of the world's annual forest growth is presently utilized for industrial and fuel wood. Large areas of non-commercial forests and forest residues can be used for fuel where needed and economical. Short rotation forestry is considered for energy production where natural forests cannot supply the needed fuel. This concept of wood energy plantations is very attractive because of high yields and uniform and accessible biomass harvests. Thus, it has become a much studied proposition in many countries, including Sweden and Canada. Sweden depends on imported oil for 80% of its energy needs. This country has undertaken a program of self-reliance in energy and envisages forest biomass contributing 46% of its total energy needs. Most of the biomass will be produced in willow energy plantations. The Swedish Energy Forestry Project is active in research and demonstration. Research includes production models, eco-physiological yield potential, species selection, mechanization, and socio-economical impacts. Demonstration is on two pilot farms, on abandoned farmland and peatland. Canada has expanded its versatile hybrid poplar plantation program for energy production. Mini-and midi-rotation biomass plantations are suitable for northern sites, but need frost resistant, fast-growing clonal stock of poplars and willows. Breeding work for the same is in progress and shows promise. 10 refs.

30194 (YEDT–CE02912, pp. 333-340) **Vegetative propogation of Alnus crispa.** Stoehr, M.U. (School of Forestry, Lakehead Univ., Thunder Bay, ON (Canada)); Farmer, R.E. Jr. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Six experiments over the course of the 1982 growing season were conducted with physiologically juvenile and mature Alnus crispa cuttings to test the effects of hormone treatment and collection data on rooting. In two of these experiments the juvenile cuttings were taken from shoots sprouting from the base of mature stems. For the four other experiments, juvenile cuttings were taken from shoots that were induced by pruning mature stems in the spring of the same year. Juvenile cuttings rooted significantly better than mature cuttings. Rooting was highest (92%) for juvenile cuttings collected on August 25 and treated with 1.0% indolebutyric acid (IBA) in 50% ethanol for 5 seconds. Mature cuttings generally rooted poorly. Best rooting (46%) was observed when the mature cuttings were collected on July 29 and treated with a mixture of two fungicides (Captan and Benlate) and 1.0% IBA and 1.0% 1-phenyl-3-:methyl-5-pyrazolone (PPZ) in talc. The results of this study indicate that green alder from the Thunder Bay, Ontario area can be successfully propagated vegetatively if rejuvenated cuttings are treated with IBA. The ability to clone green alder allows simple evaluation of genetic variation in growth rate, shade tolerance, and nitrogen fixation, all important characteristics in use of alder under intensive management in species mixes. 3 refs., 1 tab.

0909 Processing

Refer also to citation(s) 30207, 30214

30195 (AFME–85.09.1134) **Briquetting of agricultural and forestry residues in the developing countries: a synthesis of the publications on this subject and a summary of experiences.** Louvel, R. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Mar 1986. 90p. (In French). Order Number DE90784639. Available from NTIS (US Sales Only), PC A05/MF A01.

The state of the art in compaction (briquetting) of the agricultural and forestry residues is presented through a bibliographic study and experiments synthesis. Small-scale (village level) and big-scale densification equipment are reviewed and related to real local conditions in the developing countries, such as fire place and furnace technology, economic feasiblity of a press system, resource availability, etc. Recommendations are given for research and development strategies.

30196 (ETSU-B–1164) **Landfill gas research and development studies: Calvert and Stewartby landfill sites: Final report - 1988.** Leach, A.; Moss, H.D.T. Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div.; Shanks and McEwan (Southern) Ltd., Bedford (UK). 1989. 66p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report describes the final phase of a research, development and monitoring programme undertaken on plant and equipment used in the collection and utilisation of landfill gas from domestic refuse. The effectiveness of different well designs and their relationship with capping and water management within landfill sites has been evaluated by installation and testing of different well types and the use of different capping materials and thicknesses. Also the reduction of leachate levels within the refuse was attempted by means of borehole pumps. The monitoring of existing and new gas abstraction equipment including condensate knockout pots, compressors and chillers has been undertaken. (author).

30197 (ETSU-B–1246) **Presence or absence of anaerobic fungi in landfill refuse.** Theodorou, M.K.; King-Spooner, C.; Beever, D.E. Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div.; Agriculture and Food Research Council, Hurley (UK). Inst. for Grassland and Animal Production. 1989. 40p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The main objective of the research in this report was to provide evidence for the presence or absence of anaerobic fungi in landfill refuse obtained from several sites in the UK. The first section of the report provides a review of the literature concerned with the isolation, enumeration and culture of anaerobic fungi from the rumen and from faeces. The second part of the report provides a precise account of the research which was carried out for ETSU on the presence or absence of anaerobic fungi in samples of landfill refuse. The third and final part of the report contains appendices which are relevant to the subject area in general and to the research report in particular. (author).

30198 (ETSU-B–7050) **Monitoring and technical assessment of R and D into methods of landfill gas abstraction and utilisation.** Emberton, R.; Campbell, D. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div.; Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 90p. (AERE-G–4772). Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report describes the second phase of a programme of research aimed at improving the techniques used in, and economics of, landfill gas utilisation in the United Kingdom. The work was undertaken between 1984 and 1987 by the Environmental Safety Centre (ESC) and London Brick Landfill/Shanks and McEwan Ltd (SME). Topics covered include the relationship between well design, capping and water management within landfill sites and abstraction of landfill gas; the effectiveness of installed gas pumping, piping and gas handling plant; means by which gas production might be enhanced; the relationship between leachate quality and gas production; and an economic assessment of various methods of abstracting gas and of gas treatment and utilisation. (UK).

30199 (FRNC-TH–3331) **Methane and organo-sulfurous volatile compounds biosynthesis with clostridium sp. bacteria.** Niel, P. Paris-5 Univ., 75 (France). Sep 1987. 199p. (In French). Order Number DE90784637. Available from NTIS (US Sales Only), PC A09/MF A01.

The production of carbides (and especially methane) and of organo-sulfurous compounds among the clostridium populations and other micro-organisms is examined. The analysis of various biological samplings (soils, sediments...) shows the presence of many chemical compounds whose origin, in many cases, is unknown. These samplings are revealed to be, generally, biotopes for clostridium. The carbides and sulfured compounds detected in

these biotopes are listed. It is shown that several of the detected compounds are produced by pure populations of clostridium.

30200 (NSLF–7) **Small scale chipping trials in Nova Scotia.** Nova Scotia Dept. of Lands and Forests, Truro, NS (Canada). Mar 1988. 11p. (MICROLOG–90-02227). Available from PC Nova Scotia Dept. of Lands and Forests, Toronto-Dominion Bank Bldg., 1791 Barrington St., PO Box 698, Halifax, NS, CAN B3J 2T9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

A cooperative trial between the province of Nova Scotia and the Government of Canada was established to evaluate small scale chip production from various biomass sources, to determine the feasibility of using a small roadside chipper in conjunction with conventional logging equipment for fuel chip production, to determine production volumes, rates and costs associated with various harvesting operations and sources of new material, and to identify phases of this system which require modification. Five sites were selected as trial locations. Prior to treatment a point sample cruise was done at each location to determine stand characteristics. No modifications were made to the extraction equipment for handling unmerchantable biomass. Production rates and costs for felling and extraction and chipper productivity and production costs are given for each location, along with trucking costs and volume production. The study provided information on the increase in yields which can be achieved from various harvesting operations, the types of chip operations and stand types which show the greatest promise for producing chips at an economical price, and the relative costs and production associated with various types of small scale chip operations. 8 tabs., 4 refs.

30201 (YEDT–3766-4-20) **Pelly Crossing wood chip boiler: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). 11 Mar 1985. vp. (CE–02920). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Pelly wood chip project has demonstrated that wood chips are a successful fuel for space and domestic water heating in a northern climate. Pelly Crossing was chosen as a demonstration site for the following reasons: its extreme temperatures, an abundant local supply of resource material, the high cost of fuel oil heating and a lack of local employment. The major obstacle to the smooth operation of the boiler system was the poor quality of the chip supply. The production of poor quality chips has been caused by inadequate operation and maintenance of the chipper. Dull knives and faulty anvil adjustments produced chips and splinters far in excess of the one centimetre size specified for the system's design. Unanticipated complications have caused costs of the system to be higher than expected by approximately $15,000. The actual cost of the project was approximately $165,000. The first year of the system's operation was expected to accrue $11,600 in heating cost savings. This estimate was impossible to confirm given the system's irregular operation and incremental costs. Consistent operation of the system for a period of at least one year plus the installation of monitoring devices will allow the cost effectiveness to be calculated. The wood chip system's impact on the environment was estimated to be minimal. Wood chip burning was considered cleaner and safer than cordwood burning. 9 refs., 6 figs., 6 tabs.

30202 **Aerobic microorganism for the degradation of chlorinated aliphatic hydrocarbons.** Fliermans, C.B. To Dept. of Energy, Washington, D.C. USA Patent 4877736/A/. 31 Oct 1989. Filed date 12 Oct 1988. USA Patent Application 7-255,429–. Int. Cl. C12N 9/00. 8p.

This patent describes a chlorinated aliphatic hydrocarbon- degrading micro-organism. It has American Type Culture Collection accession numbers ATCC 53570 and 53571, in a biologically pure culture aseptically collected from a deep subsurface habitat and enhanced. It mineralizes trichloroethylene and tetrachloroethylene to HCl, H_2O and CO_2 under aerobic conditions stimulated by methane, acetate, methanol, tryptone- yeast extract, propane and propane-methane.

0910 Properties and Composition

30203 (CICS–CE02996, pp. 40-43) **Cereal straw ashes compositional analyses and their fusibility characteristics.** Bining, A.S. (Technical Univ. of Nova Scotia, Halifax, NS (Canada)). Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Cereal straw, has a large potential as a fuel for combustion and gasification systems. Serious problems of clinker formation, slagging, and excessively high corrosion and rapid deterioration of reactor walls have been exerienced while using straw as fuel. The main cause of the problems is smelting of straw ash at high combustion temperatures. The severity of the problems is directly related to the chemical composition of ash which in turn affects its deformation and fusion temperatures. The presented study deals with the chemical composition analyses and fusibility characteristics of ashes derived from four major cereal straws: wheat, barley, oats and rye. The analyses were conducted using the ASTM Standard Test Methods. The average straw ash content of straw samples under study varied from 1.80 weight percent to 7.23 weight percent among 12 different samples of straw. A wide variation in straw ash content was observed among straws derived from different crops. 2 tabs.

0920 Combustion

Refer also to citation(s) 30599

30204 (CICS–CE02997, pp. 80-82) **Research needs in industrial wood combustion.** Adams, T.N. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The purpose of this paper is to review the processes involved in the 2 main industrial wood combustion applications, boilers and furnaces, and to identify the pieces of research needed for the optimum design of the wood combustion equipment. Wood and bark are considered to be very reactive fuels because of their high volatile content and porous residual char. The main difficulty with industrial wood combustion in bed burning units is to mix the gases with the air so as to ensure complete combustion. The second problem is the carry-over of unburnt char. The third problem is that the air flow is attracted to the locations where the bed is thinest. The costs and benefits of pulverized wood are discussed. The wood must be dried to 15% moisture at most, and the wood particles must be reduced in size. A recent study has shown that wood with 20% moisture content, and a size distrubtion much larger than for coal, can be burnt stably in a specially designed swirl burner. The specific physico-chemical processes involved in the industrial combustion of wood particles suggest a variety of research areas. For the wood combustion systems which use bed burning, and particularly for stoker-fired systems, these areas are the mechanisms and rates of wood particle combustion in a non-uniform bed arrangement, the mechanisms of char particle combustion, and gas mixing by over-fire air jets. For pulverized wood combustion, the key research areas are the rate of drying and volatilization of small wood particles, and the rate of char combustion for the larger particles as a function of species and bark/wood ratio.

30205 (QER-ERI–6460-13) **Wood-fuelled thermal power plant and sylviculture.** Quebec Ministere de l'Energie et des Resources, Quebec, PQ (Canada). Jun 1979. 180p. (CE–02923). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report is a provisional study of a wood-fueled power plant, based on the integration of forestry with energy production. Huge, once highly productive forest lands in southern Quebec have been degraded with time and are presently occupied by non-commercial species of trees. It would be desirable to cut these trees and to reforest the land with commercially valuable species, but this is not economical if no use is found for the cut wood and the wood wastes. This report is a preliminary evaluation of a proposal to use the wood to generate electric power. Five wood supply areas and 5 corresponding sites for the power plant have been chosen. The first part of the report discusses forest management strategies, harvesting, chipping and transportation methods, the cost of the raw material, and the corresponding capital and labour costs. The second part reviews the advantages and disadvantages of the main methods of burning wood, gives estimates of the production of steam and of the power capacity according to the supply of wood available, gives estimates of the capital and operating costs of the power plant, and discusses briefly the environmental impacts of the project. The third part of the report deals with the socio- economic impacts of the project in terms of actualized cash flow and of jobs created. In the fourth part, it is recommended to undertake a feasibility study. The site of Cabano, on the south shore of the Saint Lawrence River, is preferred, with a relatively small power capacity of 20 MW and a yearly consumption of 113,400 dry-bone tonnes (d.b.t.) of wood at a cost of Can $22.42/d.b.t. 32 figs., 67 tabs.

30206 (YEDT–CE02912, pp. 423-447) **Wood gasification for power generation.** Philipp, S. (Snow Shoe Inn Inc., Fort Providence, NT (Canada)); Ferguson, D. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report was commissioned by CREDA (Conservation and Renewable Energy Development Agreement) to provide the results of the experience gained from the construction and operation of a wood gasification system for electrical power generation. The operating experiences have highlighted problems which, for the most part, have been overcome. The major existing problem is that of unwanted air entering the gasifier during each feeding cycle. This problem is aggravated by the necessity to provide an increased number of smaller feeds to prevent bridging of the wood chips within the airlock. As mentioned in the test report (included as an appendix) the inrushing air appears to be the major factor in creating engine stalls. A new feeding arrangement is presently being considered, but to date this is an unproven system with no guarantee of totally solving the problem. The future of wood gasification in this application is uncertain, but if it can be made into a more reliable system, the benefits are clear. 8 figs., 1 tab.

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30186, 30201, 30206, 30599

30207 (CONF-900117–2) **Woody biomass production costs in the United States: An economic summary of commercial Populus plantation systems.** Strauss, C.H. (Pennsylvania State Univ., University Park, PA (USA). School of Forest Resources); Wright, L.L. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 14. annual conference on energy from biomass and wastes; Lake Buena Vista, FL (USA); 29 Jan - 2 feb 1990. Order Number DE90010147. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Production costs for commercial-sized Populus plantations were developed from a series of research programs sponsored by the US Department of Energy's Short Rotation Woody Crops Program. Populus hybrid planted on good quality agricultural sites at a density of 2100 cuttings ha^{-1} was projected to yield an average of 16 Mg (OD) $ha^{-1}yr^{-1}$. Discounted cash flow analysis of multiple rotations showed pre-harvest production costs of $17 (US) Mg^{-1}(OD). 19 refs., 1 fig., 3 tabs.

30208 (NEI-SE–56) **Wood fuels -89. Production and use of wood fuels 1988.** Statens Energiverk, Stockholm (Sweden). 30 Sep 1989. 60p. (In Swedish). Order Number DE90770776. Available from NTIS (US Sales Only), PC A04/MF A01.

The wood fuels market in Sweden is reviewed for 1988 and the 5 previous years. 1988 the production amounted to 14-15 Mm^3, mostly wastes from the wood and pulp industry. The availability of wood fuels is practically limited from technical, ecological and economic reasons, but could probably be doubted without any problems. Including spent liquors from pulping, more than 60 TWh of energy is yearly produced from wood fuels in Sweden. Prices vary considerable between different types of wood fuel, and tend to be slightly above the prices for coal or peat per unit of energy produced. (L.E.).

30209 (PB–90-179854/XAB) **Cost, time, and benefit measures for personal use fuel-wood collection in Colorado. Forest Service research paper.** Betters, D.R.; Markstrom, D.C.; Aukerman, R. Forest Service, Fort Collins, CO (USA). Rocky Mountain Forest and Range Experiment Station. Jan 1990. 8p. (FSRP-RM–287). Available from NTIS, PC A02/MF A01.

The average fuel-wood collector is willing to pay, beyond current perceived costs, an additional $21 to $29 per cord in order to continue collecting fuel-wood. The difference between willingness-to-pay estimates for fuel-wood collection and for wood purchased from a commercial vendor is assumed to present recreational value of fuel-wood collection. On that basis, the recreation values for the average collection is estimated to be between $6 and $12 per cord.

30210 (YEDT–CE02912, pp. 247-250) **Wood use in commercial buildings: Is it cost effective?.** Baxter, R.W. (Energy Branch, Government of Yukon, Whitehorse, YU (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper considers the two basic types of measures available to a commercial operation which are designed to reduce energy costs. These are supply items (increasing the cost effectiveness of supplying energy) and demand items (reducing the need for heat within the building). Fuel substitution is a supply measure. In Yukon, the choices of substitution are minimal, basically limited to wood, as oil, electricity, and propane tend to be similar in price. When wood is used, however, the convenience of automatic feed and easy storage disappear, which represents a real cost to the building operator. These real costs are examined, not so much to determine their value accurately, but rather to get a feel for their cumulative magnitude. The real economics of wood are then compared to the alternatives. While anyone may dispute the values attached to the various tasks required to burn wood, the concept of evaluating more than only the obvious cost of the delivered energy when conservation or substitution is contemplated is sound. 1 tab.

30211 (YEDT–CE02912, pp. 343-359) **Assessment of the economic impact of a wood fuel industry.** Brandon, R.J. (IEA Consulting Group Ltd., Charlottetown, PE (Canada)); Mason, G.W. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper presents a review of recent demonstrations and activities in wood fuel technology in Prince Edward Island. There are some demographic similarities between the Yukon and P.E.I. such

as a small population and limited secondary industry. The regions also have forest resources with low utilization and dependence on oil for space heating requirements. Recent analysis of the economic impacts of a potential wood fuel industry on P.E.I. may have some conclusions that are also relevant in the Yukon. The study group used a simplified Delphi approach to determine the structure of a wood fuel industry in 1990. With this structure the primary and secondary economic impacts on the provincial economy were determined. These impacts include job creation, tax generation and subsidy displacement. As an example, the recent installation of a 3 million BTU/hr. woodchip fueled heating system in a hospital in P.E.I. is examined and the economic viability of this installation presented. The initial performance of the unit indicates that the $360,000 project has an internal rate of return greater than 16% with an annual job creation potential of 1.1 manyears. Additional benefits are discussed. 7 refs.

30212 (YEDT–CE02912, pp. 361-373) **Wood residues enterprising energy.** Owens, E.T. (New Brunswick Research and Productivity Council, Fredericton, NB (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A coordinated program of projects based on wood residues to be used in generating heat for homes and industry in New Brunswick is reviewed. The funding for the program is through the federal-provincial Conservation and Renewable Energy Demonstration Agreement. The objective of the program is to commercialize the demonstrations. A number of means have been undertaken to inform the public of the results of this program. Regional workshops have featured the use of chips and sawdust for commercial and institutional heating as alternatives to oil heating. Booklets or brochures and three final reports of completed projects have been published. These publications are available in the province's two official languages. Project summaries of the 14 projects within the Wood Energy Program are being published, and periodic articles for local and provincial journals are standard. Several small and large scale pilot projects are examined and evaluated. 11 refs.

30213 (YEDT–CE02912, pp. 399-406) **Woodchip fuel potential in Newfoundland and Labrador to replace oil in existing boilers and furnaces.** Graham, P.M. (Dept. of Mines and Energy, St. John's, NF (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The maximum potential on the island of Newfoundland for medium and small scale woodchip burning and process heat in boilers less than 5 MW capacity is approximately 150,000 green tonnes per year. The potential demand includes 90 cubic metres per year (20,000 gallons per year considered medium scale) and 200 boilers and furnaces with an oil consumption of 23-90 cubic metres per year (5,000 - 20,000 gallons per year considered small scale). Beyond these limits there is the large scale industrial woodchip burning potential of approximately 110,000 green tonnes per year in existing boilers and kilns at three paper mills and a cement manufacturer. There is also some limited potential for residential scale chipburning. This preliminary analysis is limited to the replacement of oil in existing buildings since this market is stable and combustion systems are commercially available at reasonable prices. The analysis shows 238 potential users with a total potential demand of 205,000 green tonnes/year. 2 tabs.

30214 (YEDT–CE02912, pp. 409-421) **From forest to farm.** Barton, G.M. (Wood and Bark Folige Chemist, Kion's Bay, BC (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper discusses possible uses for green forest slash. Following a brief review of the use of tree foliage in the Soviet Union as a poultry and animal feedstuff, studies involving Canadian species such as black spruce (Picea glauca) were discussed. These studies examined chemical composition, separation techniques, poultry and animal feeding experiments and economics. The results of animal feeding tests on chickens, rats and sheep were not good and it was concluded that the conifer based feedstuff had the nutritional value of medium grade hay. Mechanized harvesting, together with transportation of whole trees to the mill and a central delimbing and slash-chipping facility results in a reduced wood harvesting cost and a supply of chipped green slash fuel at the mill site at no cost. The chipped green slash delivered to the mill is a valuable source of fuel and 213,000 tons per year at a fuel value of $14.25/ton can save approximately 3 million dollars annually. 20 refs., 2 tabs.

0940 Transport, Handling, and Storage

Refer also to citation(s) 30206

30215 (YEDT–CE02912, pp. 375-397) **Densified fuel from land clearing biomass; and long-term chip storage for fuel: Interior Alaska.** Sampson, G.R.; Ruppert, F.A.; McBeath, J.H. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Unusable tree and moss residue from land clearing in interior Alaska was collected, milled, dried, and densified into fuel log form. Four different species combinations were tried, and all produced suitable fuels. Feasibility of a commercial facility to convert this material into a densified fuel is limited by unsatisfactory long-term storage characteristics of the product and high ash content for moss material. Winter chipped white spruce placed in a large open pile did not stay frozen over the long term in interior Alaska. After a portion of the pile warmed to 5°C and warmer, microbial activity provided heat up to 50°C to melt adjacent chips and warm them to about 5[degree]C when self-heating activity began. It does not appear to be feasible to densify the moss layer because it has a high mineral content of up to 25 to 30 percent found in the Delta Junction area. Moss from areas not subject to prevailing winds carrying silt from glacial stream beds may be suitable for densification into fuel logs, but this material was not tested in this study. The fuel logs could be only marginally price competitive with coal for home heating systems in the Fairbanks area or other areas where coal can be brought in by rail. Densified fuel logs can be very price competitive with dried, cut-to-length firewood. 8 refs., 6 figs., 2 tabs.

0950 Environmental Aspects

Refer also to citation(s) 30201, 31351, 31413

0980 Waste Management

Refer also to citation(s) 30538

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 29953, 29960, 30186

1003 Properties and Composition

Refer also to citation(s) 30908

1005 Transport, Handling, and Storage

Refer also to citation(s) 31641

1007 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30186

1009 Environmental Aspects

Refer also to citation(s) 29995, 30494

13 HYDRO ENERGY

Refer also to citation(s) 30498, 30500, 30509

30216 (EMR–CE02998) **Canadian small hydro developers course.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. vp. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This course, which was developed and funded by Energy, Mines and Resources Canada, is designed for the persons directly involved in the development of small hydro sites, namely owners and developers, consultants, component suppliers, and government staff. The course covers all the aspects of site development, including site availability, project planning and implementation, economic analysis, financing, and operation and maintenance. Other issues described are provincial site disposition policy, environmental considerations, provincial utility policies for the purchase of electric power, and small hydro in remote regions. There is a short glossary of terms relevant to the purchase of electric power. Thirteen papers have been abstracted from this manual.

30217 (EMR–CE02998, pp. 1-11) **Unique considerations of small hydro in remote regions.** Schwartz, F.H. (Scenario, Toronto, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

In the small power engineering approach, a calculation of expected energy production and of the resulting revenue is prepared and only then are decisions made as to how to develop the site. Several remote hydro power plants have been constructed in Canada over the past few years; each of these has involved a serious attempt to provide reliable power and minimize costs. Experience acquired in the different parts of Canada is reviewed. A known potential exists for at least 40 MV of small hydro power development near remote communities, tourist lodges and industries. The roles of the various jurisdictions involved (federal, provinicial and territorial governments, Indian and Northern Affairs Canada, communities and native organizations), the approaches to site development (sale of power to utilities or to communities, turn-key or owner-developed installations), the constraints of construction at remote sites, and juridicial considerations (including land claims) are discussed. Remote sites are more challenging to develop than southern sites; they demand innovative engineering, cost control, a familiarity with local issues and relations, and commitment.

30218 (EMR–CE02998, pp. 27) **Project planning.** Steeves, G.L. (Cumming Cockburn Ltd., Willowdale, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This chapter lists the different types and aspects of small hydroelectrical power projects and outlines the physical factors (developable head, development capacity, hydrology, geological and environmental factors, hydraulic gradient, and dam size) to be considered in the planning of such a project. The various levels of study undertaken in project evaluation, as well as the planning stages of project implementation, are reviewed; the technical, economical, environmental and institutional factors affecting project feasibility are listed. Specific directions are given as to how to get started, including how to select consulting engineers, how to work with government agencies, and what time frame should be expected. The conventional and turn-key approaches to site development are compared. Estimates of civil engineering and other costs in proportion of the total cost of the development of a project are provided. 4 figs., 3 tables.

30219 (EMR–CE02998, pp. 1-10) **Overview of Canadian development process - current activity & directions.** Passmore, J. (Passmore Associates, Ottawa, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This chapter looks at the technical, economic and political problems which determine the feasibility of a small hydroelectrical project, and at the capability of Canadian small hydro companies to deal with these problems. The federal and provincial approval procedures are outlined, the focus being on Ontario; the importance of involving environmental and public interest groups in project planning from the outset is underlined. According to manufacturers and consulting firms working in small hydro in Canada, there is nothing in technology that Canada cannot provide and nothing in terms of head and capacity that she cannot deal with; this assumption is discussed. The prospects of the international markets and the economic value of new sources of electric power are briefly discussed; the policies of the provincial utilities for the purchase of electric power are reviewed. There is no substantial domestic market for small hydro in Canada at the present time. For this situation to change, the large potential markets of British Columbia, Ontario and Quebec should be developed. Such development cannot be expected to take place unless the provincial governments provide strong direction to their utilities. Since, at the same time, the US and European markets are becoming increasingly constrained, the only immediate potential growth area for small hydro technology and services is the Third World.

30220 (NBES–2064) **The electrical department of the city of Edmundston low head hydroelectric development project: Final report.** Picard, J.J. (Nordic Consultants Ltee., Edmundston, NB (Canada)). New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 36p. (CE–02974). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

There are only a few areas in the Province of New Brunswick, like the City of Edmundston, where electrical distribution systems are independently owned. Although most of the electricity is purchased from the New Brunswick Power Commission, 7% is generated by the City of Edmondston at the low-head hydroelectric generating station it owns on the Green River, approximately 13 miles north of Edmundston. For about 10 years, the City had been considering an increase in the power generating capacity of the 950 kW Green River station; the increasing costs of electrical energy gave a further justification to this project. After a positive feasibility study, the City initiated the project in the fall of 1982. It was completed in the fall of 1984. The project included the installation of 2 additional 1 MW horizontal tube type turbine and

generator units. Major modifications were carried out on the power house, the transformer, the control system and the electricity supply transmission lines. The installation and monitoring of the project are discussed. Since start-up, in the Fall of 1984 to the present, under conditions of continuous power generation, the project has been a success. The total cost of the project was Can $3.66M, of which Can $0.1 were paid through the Canada/New Brunswick Conservation and Renewable Energy Demonstration Program, and Can $0.8, through job creation programs; the pay-back period is estimated to be 13.5 y. 2 figs., 2 tabs.

30221 (PB–90-182098/XAB) **Review of power operation and maintenance program. Communication and control.** Bureau of Reclamation, Denver, CO (USA). 1989. 9p. Available from NTIS, PC A02/MF A01.

The report reviews an inspection of communications equipment at Pacific Northwest dams. At each stop, the team checked for proper posting of current radio-frequency authorizations and the existence of a proper logbook containing all previous reclamation forms 7-2200, test results, and radio-equipment maintenance log. Antennas and feedlines were visually inspected, and then fade-margin tests were accomplished by the respective technicians using calibrated attenuator equipment.

1301 Resources and Availability

Refer also to citation(s) 30499

30222 (CHA–89-05632) **IMP: integrated method for power analysis.** Howard (Charles) and Associates Ltd., Victoria, BC (Canada). Mar 1989. 257p. (MICROLOG–89-05632). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An integrated, easy to use, economical package of microcomputer programs has been developed which can be used by small hydro developers to evaluate potential sites for small scale hydroelectric plants in British Columbia. The programs enable evaluation of sites located far from the nearest stream gauging station, for which streamflow data are not available. For each of the province's 6 hydrologic regions, a streamflow record for one small watershed is provided in the data base. The program can then be used to generate synthetic streamflow records and to compare results obtained by the modelling procedure with the actual data. The program can also be used to explore the significance of modelling parameters and to develop a detailed appreciation for the accuracy which can be obtained under various circumstances. The components of the program are an atmospheric model of precipitation; a watershed model that will generate a continuous series of streamflow data, based on information from the atmospheric model; a flood frequency analysis system that uses site-specific topographic data plus information from the atmospheric model to generate a flood frequency curve; a hydroelectric power simulation program which determines daily energy output for a run-of-river or reservoir storage site based on selected generation facilities and the time series generated in the watershed model; and a graphic analysis package that provides direct visualization of data and modelling results. This report contains a description of the programs, a user guide, the theory behind the model, the modelling methodology, and results from a workshop that reviewed the program package. 32 refs., 16 figs., 18 tabs.

30223 (EMR–CE02998, pp. 1-56) **Small hydro sites inventory and potential for development.** Tung, T.P. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)); Bertrand, D.G. Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

In recent years, the Canadian government has supported the development of small scale and low head hydroelectrical power sources through a variety of initiatives. It has been estimated that there is a potential of 2000 MV at more than 1000 sites of less than 10 MV. Some potential has been identified in most of the provinces for both grid-connected and remote service applications; the largest potentials have been identified in Quebec, Ontario and British Columbia. For each region, the methodology of site inventory, assessment and screening is discussed; results on the existing and potential power capacity of sites of less than 10 MV capacity are provided for Quebec, Ontario, British Columbia, New Brunswick and Prince Edward Island, Nova Scotia, Newfoundland and Labrador, and the Prairie Provinces and Northern Territories, with a cost-benefit analysis provided in each case. 1 fig., 40 tables.

1302 Site Geology and Meteorology

Refer also to citation(s) 30222

1303 Plant Design and Operation

30224 (EMR–CE02998, pp. 1-13) **Operations & maintenance.** Lampa, J. (Klohn Leonoff Ltd., Richmond, BC (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This chapter is devoted to a review of the components which affect the operation of small hydro plants, to some common operational and maintenance problems, and to an estimate of the relevant costs. Typically, the capital cost of equipment in a small hydro project is higher than the cost of electro-mechancial civil engineering and hydraulic components, sometimes more than twice. Operation, maintenance and inspection are discussed for intakes, canals, penstocks, power houses, turbines, generators, and control systems. Estimates of operating and maintenance cost are provided for typical 500 kW, 1 MW and 10 MW plants, either fully attended or remotely controlled. It appears that remote control is essential to keep the cost low, unless the labour is free. It is recommended that small-hydro plants be designed to operate without attention on a day-to-day basis and that some sort of signal be installed to notify off-site personnel of faults or shut down. 2 tabs.

30225 (OH/RD–89-181-K) **DeCew Falls GS [generating station]. Beaver Dams pumphouse concrete condition survey.** McColm, E.J. Ontario Hydro Research Div., Toronto, ON (Canada). 1 Sep 1989. 21p. (MICROLOG–90-00418). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A concrete condition survey was carried out on the Beaver Dams (Ontario) hydroelectric powers plant's pumphouse. In a portion of the north abutment walls and the deck, the concrete was found to be deteriorated. Cracking with efflorescence was noted on the surface of the piers supporting the pumphouse; however, drill core investigations showed that the interior concrete from these piers was of good quality, with an average compressive strength of 50.8 megapascals. Based on this survey, it is recommended that the deteriorated concrete in the abutment walls and the deck be removed and replaced. During this remedial work, it may be found that some of the surface concrete in the piers will also require removal and replacement. 12 figs., 1 tab.

30226 (YEDT–3766-4-6) **Remote micro hydro: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Mar 1985. vp. (CE–02914). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The micro-hydro project, built on a small tributary of Cowley Creek, near Whitehorse, Yukon, is an important step in the development of alternative energy sources and in conserving expensive diesel fuel. In addition to demonstrating the technical aspects of harnessing water power, the project paved the way for easier regulatory procedures. The power will be generated by a 9 meter head and a 6 inch crossflow turbine. The 36 V DC power will be stored in three 12 V batteries and converted to ac on demand by a 3,800 watt inverter. The system will produce 1.6 kW or 14,016 kWh per year with a firm flow of 1.26 cfs. This is sufficient to supply electricity for household needs and a wood working shop. The project is expected to cost about $18,000 and is more economical than tying into the present grid system, or continuing to use a gasoline generator. An environmental study determined that any impact of the project on the stream would be negligible. It is expected that no other water users will be affected by the project. This pilot project in micro-hydro applications will serve as a good indicator of the viability of this form of alternate energy in the Yukon. The calculations comparing the micro-hydro and grid system indicate that the mico-hydro system is a viable source of inflation-proof power. Higher heads and larger flow resulting in ac generation in excess of 10 kW would yield much better returns than this project. 3 tabs.

1304 Legislation and Regulations

Refer also to citation(s) 30226

30227 (EMR–CE02998, pp. 26) **Approaches to project implementation.** Montmorency, D.G. de (Howden Galt, Scarborough, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

Some long-term goals of a small hydroelectrical power project are to make maximum use of the resource available, to maximize the return on investment, to maximize the reliability, to achieve easy operation and repairs. Some of the short-term goals are to meet the development budget, to reduced risk as much as possible, and to gain as much control as possible on the project. A check-list of questions for use in project design is provided. These questions cover the fields of project viability and of general, civil, mechanical and electrical engineering. The past 20 years have seen the development of standardized turbine packages which lower the initial cost of the components, as well as the amount of engineering work needed to develop a site. The advantages and disadvantages of this approach are discussed. Scheduling, bids, construction, the roles of the developer, the engineer and the contractors, contracting (conventional or turn-key), financial and human risks, and compliance with the initial design are discussed. These considerations are illustrated by the case histories of 6 recent US projects, 4 of them using a conventional contracting approach and 2 using a turn-key approach. 3 figs.

30228 (EMR–CE02998, pp. 1-16) **Ontario small hydro crown site release policy.** Crawford, I.M. (Ontario Ministry of Natural Resources, Toronto, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The Government of Ontario, through the Ministries of Natural Resources and Energy, has a policy to encourage the development of small, privately owned, hydroelectrical generating stations. As the ultimate purchaser of the electricity produced from most hydroelectrical power developments, Ontario Hydro is closely involved in the release of potential sites. The potential sites are divided into 4 categories. The first (Crown land sites with no existing facilities in place, with an average power capacity of up to 5MV) are generally offered on a first come, first served basis. The second (Crown land sites with no existing facilities in place, with an average power capacity larger than 5MV) may, at the discretion of the Land Management Branch, be offered by a call for proposal or else on a first come, first served basis. The third (Crown land sites with facilities, such as a dam, already in place) are generally offered by a call for proposal. The fourth (sites where the bed is Crown-owned, but one or both banks are owned by private interests) are generally offered on a first come, first served basis. The general conditions of the processing of applications and of the disposition of sites are listed, and the procedures to follow in each of the 4 cases are summarized.

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 30059, 30499

30229 (EMR–CE02998, pp. 1-9) **Optional methods of financing small hydro projects.** Heikkinen, D.J. (Stille Sutton, Chartered Accountants, Thunder Bay, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This chapter examines the various financing alternatives available to small hydro developers, the focus being on power capacities ranging from 1 to 5 MW. It is based on the author's experience in the Province of Ontario. There appear to be 3 distinct stages of financing, leading from the proponent's original idea through to the final pay-back. Set-up, construction and production, and the risks and characteristics of each of these periods are outlined. The possible sources of financing are discussed: bank loans, government financing, and leasing, difficult because of the absence of a secondary market for small hydro power plant components, venture capital corporations, and equity investment. The possible structures of a project are discussed; corporation (the most frequent option) or limited partnership. Estimates are given for the relative sources of financing at each stage of a project: As with the physical design of each project, the financial structure of each project will have some unique features. 1 tab.

30230 (EMR–CE02998, pp. 18) **Session 7, economic analysis.** Diener, S. (Diener (S.G.) & Associates Ltd., Toronto, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course.* Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

While Canada has developed about 600 MV of small hydroelectrical power (defining small as less than 10 MV), there remain nearly 3000 MV of undeveloped potential. The purpose of economic analysis is to screen these opportunities. The fundamental elements of economic analysis are described, including discounted cash flow analysis, project definition, planning horizon, nominal versus real money analysis, and discount rates. The cost components of small hydro projects are discussed, including how they should be estimated, and the use of escalation rates. The identification and estimation of project benefits are addressed; these benefits may stem from sale revenues and/or the avoided costs of electricity purchase and Diesel-based generation. The various criteria on which to base the investment decision are presented; they include the pay-back period, the return on equity investment, the net present value, and the internal rate of return on the total investment. The main sources of costing errors are reviewed, and guidelines are provided for performing sensitivity analysis. A case study illustrates the concepts and methods of the economic analysis of small hydro projects. 6 refs., 2 figs., 5 tables.

1306 Environmental Aspects

30231 (CONF-8910325–1) **Assessing cumulative impact on fish and wildlife in the Salmon River Basin, Idaho.** Irving, J.S. (Argonne National Lab., IL (USA)); Bain, M.B. Argonne National Lab., IL (USA). [1989]. 30p. Sponsored by Federal Energy Regulatory Commission. DOE Contract W-31109-ENG-38. From 9. Oak Ridge National Laboratory life sciences symposium; Knoxville, TN (USA); 24-27 Oct 1989. Order Number DE90010540. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The National Environmental Policy Act of 1969 (NEPA) alluded to cumulative impacts although no formal definition was recognized until 1978 when the Council on Environmental Quality addressed the issue. When The Federal Energy and Regulatory Commission (FERC) received over 1200 applications for hydroelectric projects in the Pacific Northwest, Federal and State Agencies, Indian tribes and environmental groups became concerned that numerous small developments could have significant potential cumulative impacts on fish and wildlife resources. In response to this concern, the FERC developed the Cluster Impact Assessment Procedure (CIAP). The CIAP consisted of public scoping meetings; interactive workshops designed to identify projects with potential for cumulative effects, resources of concern, available data and preparation of a NEPA document. The procedure was modified to assess the cumulative impacts of fifteen hydroelectric projects in the Salmon River Basin, Idaho. The methodology achieved its primary objective of evaluating the impact of multiple hydroelectric developments on fish and wildlife resources. This paper describes an application of a structured multiproject assessment method in the context of the CIAP to evaluate the cumulative impact of 15 small-scale hydroelectric projects in the Salmon River Basin of Idaho. 22 refs., 2 figs., 4 tabs.

30232 (EMR–CE02998, pp. 1-16) **Environmental impact [of small hydro projects]: Potential issues and mitigating measures.** Smythe, L.A. (Acres International Ltd., Niagara Falls, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course*. Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

Environmental impact of small hydro installations and mitigating measures are defined. Project featured inundation effects and down stream effects leading to water quality changes. The interaction between small hydro power development and the availability of usable fish is discussed, including impoundment effects, flow alterations, and the barriers to fish mobility. The impacts on historical heritage, tourism land other recreational activities are also discussed. The expectations as to land and riparian rights are outlined. A list of things to do and to avoid in dealing with environmental regulatory agencies is provided.

30233 (MH–90-02356) **Conawapa environmental impact assessment work plan.** Manitoba Hydro, Winnipeg, MB (Canada). Aug 1989. 47p. (MICROLOG–90-02356). Available from PC Manitoba Hydro, 820 Taylor Ave, PO Box 815, Winnipeg, MB, CAN R3C 2P4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Current forecasts indicate the Manitoba Hydro System will require additional energy sources by 1999. Several supply alternatives, including new generation, diversity exchanges, life extension of thermal plants and demand management are being evaluated. One option is construction of a hydro-electric generating station on the Nelson River at the Conawapa site. The environmental impact assessment (EIA) work plan presented in this document describes the schedule for and extent of EIA programs developed in the context of the current project plans. This EIA work plan covers background, objectives and scope of the Conawapa EIA program; environmental regulatory processes which related to the Conawapa project; a description of the Conawapa project including exploration, construction and operation activities; proposed Conawapa EIA program including discipline activities, review and approval schedules; and public participation activities. 2 figs.

1307 Power-Conversion Systems

Refer also to citation(s) 30434

30234 (ETSU-SSH–4043) **The performance and economics of a pneumatic water turbine.** Bullock, G.N.; Parmee, I.C. Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div.; Polytechnic South West, Plymouth (UK). 1989. 369p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report is concerned with the extraction of energy from 'ultra-low-head' sources of water power by means of a particular type of hydro-pneumatic device known as a Pneumatic Water Engine (PWE). The objective is to assess by means of an interactive combination of design studies, computer simulations and outline costing exercises, whether a PWE is likely to be cost effective. (author).

30235 (ETSU-SSH–4065) **The AUR water engine.** Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div.; AUR Hydropower Ltd., Hythe (UK). 1989. 53p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The AUR water engine is designed to harness flows down to 0.5 metre head, with a hydroelectric power output of 50kW - 100 kW and operating with a reciprocating motion rather than the rotary mode of a turbine or water wheel. The machine was tested at a mill site on the River Arun in West Sussex and Part I of this report describes the monitoring programme and efficiency tests which gave an operating efficiency of 55% for the unit at 1.7 metres head and 0.6 cubic metre per second flow. In Part II the Report defines an outline specification for a commercially sized 70kW water engine and discusses the relative merits of conventional rotating machines when compared with novel devices designed for flow rather than head, in meeting the economic criteria for long term commercial success. The report suggests the cost of electricity from a 70kW machine operating at 1.9m head, assuming annual charges of 13% of capital cost to cover amortisation, operation and maintenance costs, would be 4.8p/kW.hr. The report concludes that the project represents an essential step in moving from laboratory evaluation to a commercial demonstration of the water engine, and that confirmation of output efficiency and component design provides a helpful basis for realistic cost projections of water engines operating in the 0.5 - 2.0 metres head range with power outputs of 50 kW and above. (author).

30236 (ICLES–89/847G-31, pp. 20) **A ruggedized optical sensing system for dynamic air gap monitoring of generators in hostile environments.** Talas, P.; Toom, P.O.; Benjamin, S.M. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring*. Available from Canadian Electrical Association, One Westmount Square, Suite 500, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This paper presents the development of a ruggedized, precision fiber-optics-based air gap monitoring system and its application to on-line hydroelectric generator diagnostics and protection. The system was developed utilizing experience gained through the use of a prototype optical air gap measuring system developed with cofunding by CEA (previously described in CEA, IEEE and CIGRE publications). The system components have been redesigned to withstand severe contamination, high temperature, humidity, vibration, and acceleration. This paper describes a newly developed diagnostic/display system and the application of the system to analyze some of the before and after rotor rim-shrink characteristics of generator G8 at the GURI Generating Station in Venezuela. 3 refs., 23 figs.

30237 (ICLES–89/847G-31, pp. 15) **Rational for retrofitting a hydro-electric turbine/generator set.** Day, H. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.*

Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

The significant loss of revenue resulting from long unavailability of hydro-electric generating sets, combines with ever increasing cost to carry out major repairs necessary to insure adequate useful life of these sets, highlight the timely planning importance of the associated activities. One aspect helpful in taking decisions at the right time is the development of a technical guide defining all parameters and levels beyond which a major intervention become imperative. A description of these technical parameters and their critical levels is presented in this paper.

30238 (ICLES–89/847G-31, pp. 11) **Monitoring developments for hydroelectric generating units.** O'Kelly, J.F. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This paper gives a short introduction to the need of monitoring and a brief description of some monitoring developments. Included are rotor-mounted scanners which assess the condition of generator stator insulation while running, and display the information so that trouble spots could be identified by slot number. Also described are a bearing alignment monitor, a bearing clearance monitor, an on-line efficiency monitor, a cavitation pitting detector, and structural and geotechnical monitors.

14 SOLAR ENERGY

Refer also to citation(s) 30509

30239 (PWC/SPO–CE02925) **Solar systems design course manual, Part 2: Specialized topics.** Public Works Canada, Ottawa, ON (Canada). Solar Programs Office. Nov 1982. 143p. (CE–02925). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This manual deals with various aspects of solar heating systems for buildings. Feasibility studies of heating load assessment, location of the elements of the system, and energy conservation measures to reduce the heating load are discussed. Also discussed is the choice between air systems and liquid systems. Air cooled collectors are mainly used for space heating and for the pre-heating of the ventilation air, whereas liquid-cooled collectors are mainly used for the pre-heating or heating of air or water. Coverage is given to heat storage, heat exchangers, and the calculation of the albedo of the collectors as a function of the angle of incidence of the solar light. The third aspect is the design of solar heating systems, in particular the thermodynamical limitation on the efficiency of the collectors, the economical aspect, and safety problems. Several computer programs used in the design of solar heating systems are discussed including: FCHART, TRNSYS, WASTSUN, DOE-2, BLAST, ENERPUB, VENTAIR and ASTEPI.

30240 (PWC/SPO–CE02984) **Manual of the solar systems design course, part 3: Specialized topics (practical aspects).** Public Works Canada, Ottawa, ON (Canada). Solar Programs Office. Jun 1983. 101p. (CE–02984). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report is part of a course on the design of solar energy systems for buildings. The first part deals with heating load analysis, reference is made to the computer codes (F-Charts and Watsun), the space required for the components of the system and their mounting within the building, and maintenance. Its purpose is to help the reader to determine whether the heat load in question is a good application of solar heating, whether the solar heating system can be integrated with the existing systems, whether the space required for the components of the system is available. The second part of the report deals with heating load analysis, types of solar heating systems, installation of the collectors, choice of components for air systems (air tightness) and for liquid systems especially heat exchangers, pumps, and piping (joints, thermal insulation, passage, through walls), energy management systems, and commissioning and in-service inspection. A list of manufactures is given.

1401 Resources and Availability

30241 (TNO-TPD–618.011) **Study of the daylight in the Netherlands.** Rutten, A.J.F.; Zonneveldt, L. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Feb 1988. 81p. (In Dutch). Order Number DE90767885. Available from NTIS (US Sales Only), PC A05/MF A01.

The results of the daylight and radiation measurements, which were carried out in 1985 and 1986 in the Netherlands, are compared with the results of previous foreign measurements. The results are used to make a conversion table by which hourly radiation data with regard to the global, diffuse and direct radiation can be converted to illuminance intensity. Dependent on sun height and radiation intensity the calculated average per hour for the illuminance will have a maximum error of 10 to 20%. This method is applicated on data of the EG reference year for the energy calculations TRY (Test Reference Year). This way a reference year for daylight calculations can be developed. Comparison with foreign results show no large differences with previous measurements. 15 figs., 5 tabs., 21 refs., 6 apps.

1403 Economic, Industrial, and Business Aspects

30242 (CSR–23380-1-6734) **Photovoltaic consortiums involving France and Canada.** Simpson, J.H. (Cosim Solar Research Ltd., Ottawa, ON (Canada)). Cosim Solar Research Ltd., Ottawa, ON (Canada). Jan 1982. 27p. (CE–02987). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report considers the possibilities of a cooperation agreement between French and Canadian investors in order to produce photovoltaic (PV) devices and systems. The technical and economical situations in France and Canada are briefly described. The conclusion is that the most interesting partner for a Canadian group of investors would be Photowatt Internationale Societe Anonyme, a member of the group Compagnie Generale d'Electricite (CGE) which also comprises several battery manufacturers. The managers of Photowatt and those of the French Government's Commissariat a l'Energy Solaire have expressed their desire to have a cooperation agreement. Given the technological advance of France in the manufacture of PV cells and modules, it appears that the most promising initial thrust for Canadian cooperation is in the field of control and power-conditioning systems. Afterwards, PV cells and modules could be manufactured in Canada through an existing PV manufacturer or through a new company. The main factors affecting a cooperation agreement are discussed. 2 tabs.

1405 Solar Energy Conversion

Refer also to citation(s) 30242, 30775

30243 (DOE/CH/10093–61) **Solar thermal program summary: Volume 2, Research summaries, Fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 69p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009476. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The federal government has conducted the National Solar Thermal Technology Program since 1975. Its purpose is to provide focus, direction, and funding for the development of solar thermal technology as an energy option for the United States. More than a decade of research and development has brought solar thermal systems to a point where they have proven useful for generating electricity and process heat. Improvements to these during the 1980s led to reductions in capital and energy costs of 80%. Parabolic trough systems are now considered technically mature and

are being used in the world's largest solar electric systems, generating electricity for less than $0.12/kWh. Central receiver and dish technologies have also been demonstrated in several plants throughout the world. The cost of concentrators, the largest cost component of solar thermal systems, has dropped from $900-$1300/m^2 in 1978 to $70-$16/m^2 today, while performance has improved significantly. Solar thermal technology has also shown strong potential for advanced applications, such as destroying hazardous wastes and processing materials and chemicals. This annual summary provides an overview of the government-funded activities within the National Solar Thermal Technology Program. Tasks conducted in house by the participating national laboratories or under contract to industry and academic and other research institutions are highlighted. This document covers those activities initiated, renewed, or completed during FY 1989. 85 refs.

30244 (DOE/ER–0443) **Summary results of an assessment of research projects in the National Photovoltaics Program.** USDOE Office of Energy Research, Washington, DC (USA). Office of Program Analysis. Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. Order Number DE90008222. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Photovoltaics Technology Division of the Department of Energy (DOE) is responsible for the management of the National Photovoltaics (PV) Program. This program sponsors research and development in photovoltaics energy technology. The program is designed to facilitate accumulation of a base of scientific and technical data and experience from which private enterprise can choose options for further development and competitive application in electrical markets in the United States. At request of the Director, Photovoltaics Technology Division, the Office Program Analysis (OPA) undertook an assessment of 129 projects managed by his Division. The primary objective of the assessment was to obtain a measure of the quality of the research or development in each project. Each panel consisted of five to eight scientific or technical reviewers collectively knowledgeable in all of the photovoltaics energy technology areas touched on by the projects being assessed. The purpose of this assessment was to obtain sufficient information for DOE managers to determine the following: What is the quality research sponsored by the Photovoltaics Technology Division, as represented by its individual projects? What is the impact of individual projects within the Photovoltaics Technology Division on the mission of Solar Renewables? What are the priority research targets and opportunities for future sponsorship by the Photovoltaics Technology Division? 1 fig., 1 tab.

30245 (FRCEA-TH–249) **Real environment testing of polycrystalline silicon and hydrogen amorphous silicon photovoltaic modules fields.** Costa Sassetti PAES, P. da. CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France); Aix-Marseille-3 Univ., 13 - Marseille (France). Mar 1988. 253p. (In French). Order Number DE90784617. Available from NTIS (US Sales Only), PC A12/MF A01.

An experimental study on the actual behaviour of photovoltaic module fields (polycrystal and amorphous silicon) is presented: characteristics evolution with the time, energy efficiency of the modules and modules fields determination, and analysis of the energy consequences of the connection to the electric network. The effects of climatic conditions and PV module operating conditions are determined. The various technologies are compared.

30246 (HMI-B–465) **Unified model of charge build-up and annealing of oxide charge and interface states in SiO_2 due to stress.** Wulf, F. Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.); Technische Univ. Berlin (Germany, F.R.). Fachbereich 19 - Elektrotechnik. Apr 1989. 133p. (In German). Order Number DE90785028. Available from NTIS (US Sales Only), PC A07/MF A01.

The build-up of oxide charges, Q_{ot}, and interface states, D_{it}, during stress-irradiation or bias temperatures (BT) - as well as the annealing of these defects has been investigated. The post-stress annealing and the degradation process due to BT-stress can be explained by the chemical reaction of the hydrogen in the SiO_2. With this new model it becomes possible to describe the correlation of irradiation and BT-stress and moreover the sensitivity of MOS-devices against carrier injection as well as reverse annealing, dose rate effects and the temperature dependent D_{it}-annealing. (orig.).

30247 (KEMA–89-3013) **Fifteen years of KEMA experience with solar cells.** Van der Veer, J.H.C.; Jansen, J.W.; Posthumus, O. Keuring van Electrotechnische Materialen NV, Arnhem (Netherlands). Jun 1989. 9p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

Paper presented at the 2. national solar energy conference, Noordwijkerhout, Netherlands, 18-19 April 1989.

In 1974 KEMA (Joint Laboratories and Consulting Services of the Dutch Electric Power Supply Companies) installed a solar cell panel to study the performance of solar cells under practical conditions. The peak load of the system is nearly 400 W. To measure the performance a quality factor has been defined, based on the short current and the Zener or breakdown voltage of a module. The last fifteen years data have been collected on the quality factor and the panel contamination. Also the failures of the modules were studied in this period, which failures were mainly caused by the covering of the construction of the modules. Special attention is paid to a method to determine the series resistance of these modules on the basis of the so-called 1/f noise, a sensitive parameter in the life prediction testing of photovoltaic modules. 4 figs., 5 refs., 4 tabs.

30248 (MBB-Z–0251-89-PUB) **Structural and electronic properties of doped a-$Si_{1-x}Ge_x$:H alloys grown with H-dilution.** Wind, J. (Messerschmitt-Boelkow-Blohm GmbH, Muenchen (Germany, F.R.)); Petrova-Koch, V.; Kroetz, G.; Mueller, G.; Deimel, P.P. Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn (Germany, F.R.). 1989. 3p. Contract BMFT 13AS0022. (CONF-890861–4: 13. biennial international conference on amorphous and liquid semiconductors (ICALS-13) and the first international conference on amorphous semiconductor technology (ICAST-1), Asheville, NC (USA), 21-26 Aug 1989). Order Number DE90780254. Available from NTIS (US Sales Only), PC A02/MF A01.

Doped a-$Si_{1-x}Ge_x$:H films with improved transport properties have been obtained by plasma decomposition of $SiH_4/GeH_4/H_2$-mixtures. The beneficial effects of H-dilution are most pronounced in phosphorus doped alloys with comparable solid-state-concentrations of Si and Ge. TEM and H-effusion measurements indicate that H-dilution favours the formation of more homogeneous alloys. (orig.).

30249 (PB–90-182221/XAB) **Design optimization of short-focal-length photovoltaic modules. Technical report, 28 November 1988-31 August 1989 (Final).** Erbert, V.; Doherty, J.E.; Corio, R.P. Wattsun Corp., Albuquerque, NM (USA). Jan 1990. 79p. Available from NTIS, PC A05/MF A01.

The first tasks completed were design optimization of submodule components resulting in selection of a final module design for production. Performance testing was conducted by Sandia National Laboratories and analysis of automated manufacturing techniques was begun. A cost analysis, following the Department of Energy's guidelines, was completed along with the successful development and testing of a low cost prototype tracking system.

30250 (WU–89-05738) **Research and development of reactively evaporated a-Si photovoltaic cells.** Audas, R.D. (Univ. of Waterloo, Waterloo, ON (Canada)); Brodie, D. Waterloo Univ., ON (Canada). 29 Jul 1987. 60p. Contract EMR 24ST.23216-6-6188. (MICROLOG–89-05738). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The long term objective of this work is to produce a stable, efficient a-Si solar cell by a relatively safe inexpensive method. A reactive evaporaton process has been developed which permits the fabrication of a-Si:H, p-i-n diodes and possibly solar cells. The method makes use of a high vacuum system ($1x10^{-8}$ torr operating base pressure) with a residual gas analyzer, a precision leak valve and a variety of resistively heated, as well as electron beam sources. Films were prepared under carefully monitored and controlled conditions and characterized electrically, optically and in a

limited number of cases structually. Completed working devices have only recently been obtained and to date have been studied using only current voltage characteristics. It has been demonstrated that vacuum deposited a-Si:H can be doped by co-evaporating boron or posphorus and a p-i-n diode has been fabricated using this technique. 7 refs., 8 figs.

30251 **Current topics in photovoltaics: Volume 3.** Coutts, J.J. (Solar Energy Research Inst., Golden, CO (USA)); Meakin, J.O. 374p. Academic Press Inc., San Diego, CA (USA) (1988).

The authors discuss the steady growth in the commercial application of solar cell systems. In many parts of the world photovoltaics are being used in essential life sustaining or enhancing applications such as communications, water pumping, and vaccine refrigeration. Even in the more industrialized nations a growing number of uses are being found for photovoltaics, in areas which are surrounded by grid distribution systems. This volume covers advances in research and development, many of them in the amorphous field, although progress continues with crystalline silicon and the II-VI and III-V compounds.

30252 **Current topics in photovoltaics: Volume 3.** Coutts, T.J. (Solar Energy Research Inst., Golden, CO (USA)); Meakin, J.O. vp.Academic Press Inc., San Diego, CA (USA) (1988).

Steady growth in the commercial application of solar cell systems has been achieved since the last volume of this series was published. In many parts of the world photovoltaics are being used in essential life sustaining or enhancing applications such as communications, water pumping, and vaccine refrigeration. Even in the more industrialized nations a growing number of uses are being found for photovoltaics, some of them far from essential, in areas which are surrounded by grid distribution systems. This book covers the latest advances in research and development, many of them in the amorphous field although progress continues with crystalline silicon and the II-VI and IIIV compounds.

30253 **A 27.3% efficient $Ga_{0.5}In_{0.5}P$/GaAs tandem solar cell.** Olson, J.M. (Solar Energy Research Institute, Golden, Colorado 80401 (US)); Kurtz, S.R.; Kibbler, A.E.; Faine, P. *Applied Physics Letters (USA)*, 56(7): 623-625 (12 Feb 1990).

A two-terminal, monolithic cascade solar cell with an efficiency of 27.3% is reported. The device structure consists of a $Ga_{0.5}In_{0.5}P$ homojunction grown epitaxially upon a GaAs homojunction, with a GaAs tunnel diode interconnect. The tandem combination of these two materials is lattice matched, and has a theoretical efficiency of 34%. The device was grown by metalorganic chemical vapor deposition at 700 °C, using trimethylgallium, trimethylindium, arsine, and phosphine as sources. The minority-carrier transport properties of the $Ga_{0.5}In_{0.5}P$ are shown to be relatively insensitive to variations of the growth temperature and phosphine overpressure. Other factors that affect the efficiency of the device are presented and discussed.

1406 Photovoltaic Power Systems

30254 (TES–89-05739) **Photovoltaic monitoring database. November 1, 1986 to June 30, 1987: Final report.** TES Ltd., Ottawa, ON (Canada). Jul 1987. 96p. Contract EMR 23216-6-6113/01-52. (MICROLOG–89-05739). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Environment Canada accepted a proposal to establish a monitoring database of photovoltaic installations. Two remote hydrometic data collection units at Coppermine River, Northwest Territories, and Lake Diefenbaker, Saskatchewan, were selected as pilot sites to initiate and test the monitoring program. Each site consists of a photovoltaic array, 12-volt batteries, a voltage regulator, data collection equipment,and a satellite transmitter. it was initially proposed that the data be collected and transmitted via modem to monitoring facilities in Ottawa. Final installation had data being transmitted every 3 hours from the collection site via satellite to Washington, D.C., where it was then transferred daily to Environment Canada in Hull, Quebec. On a weekly basis, data from Hull was transferred via modem for processing and analysis. Progress reports were then produced monthly. The Coppermine River Site came on stream in November, 1986, providing eight months of data. Lake Diefenbaker started transmitting data regularly in late February, 1987, providing four months of data. Reported site parameters included insolation, voltages and currents, and temperatures. Some problems with data lost in the satellite links is reported and alternative data transfer methods are suggested. Both sites data have followed the expected trends or curves which are based on historical averages. 3 refs., 2 figs., 1 tab.

1407 Solar Thermal Power Systems

Refer also to citation(s) 30243

30255 (KEMA–89-3015) **Solar cell projects at Rheinisch Westfaehlisches Elektrizitaetswerk (RWE), Western Germany.** Van der Veer, J.H.C.; Posthumus, O. Keuring van Electrotechnische Materialen NV, Arnhem (Netherlands). Aug 1989. 10p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

In the Federal Republic of Germany a few large photovoltaic solar cell systems are operational; they can be connected directly to the public electric power network. Several types of solar cell modules are applicated. Also different supporting constructions, alternating current converters and switching circuits are used to determine the combination which will have the best results. The experiences with the first large photovoltaic solar cell system (300 kW) in Pellworm show that solar energy storage in batteries is very expensive. The new system near Koblenz, which now has a peak load of 340 kW but in the future will have a maximum capacity of 1 MW, does not store solar energy. If the energy yield of the solar cell system will be too low, the system will be disconnected from the public mains.

30256 (PWC/SPO–CE02985, pp. 23) **Technical concerns pertaining to the design and operation of solar heating installations.** Easterly, J.L. (PRC Energy Analysis Co., McLean, VA (USA)). Public Works Canada, Ottawa, ON (Canada). Solar Programs Office. [1979]. (CE–02985). In *Architectural and technical concerns pertaining to the design and operation of solar heating installations.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report describes the start-up and operation of solar heating installations in relation with their design. It discusses the priming of the system, the piping, the heat storage, the control systems, and the problems associated with the heat transfer fluids such as corrosion, leaks, freezing and over-heating. The problems of the location of the sensitive components, of thermal shock, and of the dilation and contraction of pipes are underlined. It is recommended that the installation be kept as simple as possible, so as to make trouble-shooting easier. 35 figs.

30257 (PWC/SPO–CE02985, pp. 34) **Architectural concerns in solar system design and installation.** Weinstein, S. (Ehrenkrantz Group, New York, NY (USA)). Public Works Canada, Ottawa, ON (Canada). Solar Programs Office. [1979]. (CE–02985). In *Architectural and technical concerns pertaining to the design and operation of solar heating installations.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report is about architectural considerations in solar system design, and deals with the physical problems and the economical aspects of various solutions. The choice and location of the collectors, the heat storage devices (air or water, above the ground or underground) and the problems with the piping (thermal expansion, gravity drainage, thermal insulation and waterproofing) are discussed in view of the experience of the Department of Energy with the US manufacturers. The aesthetic aspect and the need for good communications between the owner and the contractor are underlined. 73 figs.

30258 **Heat engine based on shape-memory alloys.** Goldstein, D. To Department of the Navy, Washington, DC. USA Patent

Application 7-444,350. 1 Dec 1989. 12p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

This patent application discloses a tubular gear made of shape memory alloy in sheet form, having longitudinal corrugations and being floating supported for rotation about an axis fixedly spaced from the rotational axis of a roller gear in meshing engagement with the corrugations. The tubular gear is sequentially deformed by exposure to radiated heat causing the shape memory alloy to expand circumferentially and by said meshing engagement with roller gear. Such deformation of the tubular gear within differential temperature regions established by restricted exposure to the radiated heat, induces and sustains rotation of the tubular gear to convert the heat energy into mechanical energy.

1408 Ocean Energy Systems

30259 (DOE/CH/10093–67) **Ocean energy program summary: Volume 2, Research summaries, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 33p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009482. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The oceans are the world's largest solar energy collector and storage system. Covering 71% of the earth's surface, this stored energy is realized as waves, currents, and thermal salinity gradients. The purpose of the federal Ocean Energy Technology (OET) Program is to develop techniques that harness this ocean energy in a cost-effective and environmentally acceptable manner. The OET Program seeks to develop ocean energy technology to a point where the commercial sector can assess whether applications of the technology are viable energy conversion alternatives or supplements to systems. Past studies conducted by the US Department of Energy (DOE) have identified ocean thermal energy conversion (OTEC) as the largest potential contributor to United States energy supplies from the ocean resource. As a result, the OET Program concentrates on research to advance OTEC technology. Current program emphasis has shifted to open-cycle OTEC power system research because the closed-cycle OTEC system is at a more advanced stage of development and has already attracted industrial interest. During FY 1989, the OET Program focused primarily on the technical uncertainties associated with near-shore open-cycle OTEC systems ranging in size from 2 to 15 MW_e. Activities were performed under three major program elements: thermodynamic research and analysis, experimental verification and testing, and materials and structures research. These efforts addressed a variety of technical problems whose resolution is crucial to demonstrating the viability of open-cycle OTEC technology. This publications is one of a series of documents on the Renewable Energy programs sponsored by the US Department of Energy. An overview of all the programs is available, entitled Programs in Renewable Energy.

1409 Solar Thermal Utilization

Refer also to citation(s) 30243, 30270, 30522

30260 (DOE/SF/16306–21) **Colorado State University program for developing, testing, evaluating and optimizing solar heating and cooling systems: Project status report for the months of March and April 1990.** Colorado State Univ., Fort Collins, CO (USA). Solar Energy Applications Lab. May 1990. 17p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG03-86SF16306. Order Number DE90010107. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The object of this report is to state the results of efforts to develop and test various integrated solar heating, cooling and domestic hot water systems, and to evaluate their performance. 2 figs.

30261 (IBP-WB–34/1988) **Passive solar systems for inhabited private buildings. Measurements and energetic analysis of the Rastede solar house.** IRB-Forschungsbericht. Erhorn, H.; Gertis, K.A. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.); Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 20 Jun 1988. 41p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

A demonstration project funded by the BMFT was to show how a significant reduction of private household energy consumption can be achieved with commercially available techniques and constructional concepts. For this purpose, detailed measurements were made on 22 so-called 'solar houses', constructed according to the principles of energy conservation, and 3 conventional reference houses. This report presents the energy analysis for the solar house at Rastede. (orig./KW) With 4 tabs., 12 figs.

30262 (IBP-WB–35/1988) **Passive solar systems for inhabited private buildings. Measurements and energetic analysis of the Wuerzburg solar house.** IRB-Forschungsbericht. Erhorn, H.; Gertis, K.A. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.); Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 30 Jun 1988. 40p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

A demonstration project funded by the BMFT was to show how a significant reduction of private household energy consumption can be achieved with commercially available techniques and constructional concepts. For this purpose, detailed measurements were made on 22 so-called 'solar houses', constructed according to the principles of energy conservation, and 3 conventional reference houses. This report presents the energy analysis for the solar house at Wuerzburg. (orig./KW) With 4 tabs., 12 figs.

30263 (IBP-WB–36/1988) **Passive solar systems for inhabited private buildings. Measurements and energetic analysis of the Munich solar house.** IRB-Forschungsbericht. Erhorn, H.; Gertis, K.A. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.); Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 29 Jun 1988. 40p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

A demonstration project funded by the BMFT was to show how a significant reduction of private household energy consumption can be achieved with commercially available techniques and constructional concepts. For this purpose, detailed measurements were made on 22 so-called 'solar houses', constructed according to the principles of energy conservation, and 3 conventional reference houses. This report presents the energy analysis for the solar house at Munich. (orig./KW) With 4 tabs., 12 figs.

30264 (IBP-WB–39/1988) **Passive solar systems for inhabited private buildings. Measurements and energetic analysis of 22 solar houses and 3 conventional reference buildings.** IRB-Forschungsbericht. Erhorn, H.; Gertis, K.A. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.); Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 2 Nov 1988. 96p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

A demonstration project funded by the BMFT was to show how a significant reduction of private household energy consumption can be achieved with commercially available techniques and constructional concepts. For this purpose, detailed measurements were made on 22 so-called 'solar houses', constructed according to the principles of energy conservation, and 3 conventional reference houses. This report presents the energy analysis for all buildings. (orig./KW) With 10 tabs., 28 figs.

30265 (TNO-TPD–714.019) **Optimization of the 'Zonnevang' solar boiler system.** De Geus, A.C.; Kortschot, D.J.; Van der Linden, J. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Apr 1988. 74p. (In Dutch). Project PEO 23.25-010.30. Order Number DE90767892. Available from NTIS (US Sales Only), PC A04/MF A01.

The Institute of Applied Physics of TNO (Organization for Applied Scientific Research) tested the title boiler by means of a solar simulator. The results can be used in the solar boiler calculation model to determine energy conservation possibilities during several system operations. The purpose of the test is to optimize the 'Zonnevang' solar boiler system. Two tests by means of the solar simulator were carried out to be able to give answers to the questions of collector efficiency, operation of the system according to the design specifications, reliability and energy conservation demands, and options for alterations which stimulate energy conservation, in particular with regard to flow control. The collector efficiency formula is determined by means of the test. From the indoor testing of the complete system it is concluded that it functions satisfactorily. 17 figs., 7 refs., 8 tabs., 10 apps.

30266 (YEDT–3766-4-8) **Residential solar hot water: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Jun 1982. 51p. (CE–02913). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report examines the feasibility of using solar energy to preheat domestic water coming from the city supply at a temperature of approximately 4°C. Four solar collectors totalling 7 m^2 were installed on a support structure facing south at an angle of 60° from the horizontal. The system worked most efficiently in the spring and early summer when the combination of long hours of sunshine, clear air and clear skies allowed for maximum availability of solar radiation. Performance dropped in late summer and fall mainly due to cloudier weather conditions. The average temperature in the storage tank over the 10 months of operation was 42°C, ranging from a high of 83°C in July to a low of 6°C in November. The system provided a total of 7.1 GJ, which is approximately one-third the annual requirement for domestic hot water heating. At the present time domestic use of solar energy to heat water does not appear to be economically viable. High capital costs are the main problem. As a solar system with present day technology can only be expected to meet half to two-thirds of the hot water energy demand the savings are not sufficient for the system to pay for itself within a few years. 5 figs.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 30073, 30249, 30260, 30265, 30654

30267 (DLR-FB–89-51) **Qualification of concentrating mirror systems with the measurement system HERMES and the simulation program HELIOS.** Kleih, J. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik). Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.). 1989. 53p. (In German). Available from Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany, F.R.).

An overview is given about methods to measure (direct/indirect) highly concentrated solar radiation. The methods are used to qualify solar power plants (parabolic dishes up to tower systems). In a more detail way the measurement system HERMES is described, which was developed from DLR Stuttgart. HERMES was used to examine two membrane concentrators (17 m resp. 7.5 m diameter) of the company Schlaich and Partner, Stuttgart. Maximum measured values of radiant flux density are greater than 2 MW/m^2 for the 17 m mirror resp. 9 MW/m^2 for the 7.5 m mirror, normalized to a direct insolation of 800 W/m^2. As a checking tool for the measurements the computer code HELIOS was used. There was found an acceptable agreement between measurement and calculating. (orig.) With 32 figs., 3 tabs., 30 refs.

30268 (FRNC-TH–3577) **Single and double reflexion solar radiation concentration: contribution to the control and regulation methods for facet reflective surfaces.** Henault, F. Paris-11 Univ., 91 - Orsay (France). Jun 1987. 485p. (In French). Order Number DE90784619. Available from NTIS (US Sales Only), PC A21/MF A01.

Three computer codes have been developed for the simulation of the visible luminance distributions on the reflecting component of a focusing heliostat, of a plane heliostat and of a fixed concentrator in order to determine the isoluminance curves for reflecting facets with adjustment errors (surface deformation, misalignment,...). A linear relation system is derived that allows to determine the adjustment errors from simple parameters measured directly on the experimental curves. The pulse response concept of a reflective facet is then introduced.

1420 Heat Storage

30269 (CONF-900315–3) **Contemporary issues in solar pond research.** Hull, J.R. Argonne National Lab., IL (USA). [1990]. 4p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Solar '90: 19th American Solar Energy Society annual conference; Austin, TX (USA); 18-20 Mar 1990. Order Number DE90010094. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Technical issues that are vital to the economic viability of salinity-gradient solar ponds include gradient-zone erosion, brine transparency, ground heat loss, and salt recycling. Present knowledge of these issues is summarized, and a number of promising research problems are suggested for each issue. 23 refs.

30270 (TNO-TPD–313.223) **The Netherlands national evaluation Groningen-system.** Havinga, J.; Wijsman, A. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Feb 1988. 21p. Order Number DE90767926. Available from NTIS (US Sales Only), PC A03/MF A01.

The results of an evaluation of the Duct system as seasonal heat store under Dutch climatical conditions are described. It is an update of the Dutch contribution to the IEA-VII subtask II(b)-report: 'Central solar heating plants with seasonal storage. Evaluation of concepts'. For the evaluation the MINSUN-simulation program has been used. The evaluation is done for the following total system concepts: gas-driven heat pump with unglazed solar collectors; electrical heat pump with unglazed solar collectors; no heat pump, evacuated tubular solar collectors. An evaluation for the same three system-concepts with aquifer storage will be reported as part of IEA-VII phase III. The evaluation is done for a total load of 4.4 TJ. This load corresponds with the total load of the Groningen system. The DHW-fraction is 16% (0.7 TJ). The results are presented in a 'solar costs versus solar fraction' figure. From this figure the lowest solar costs system is derived. For this optimal system the heat fluxes in the total system and the cost build-up are given. Finally the results are discussed. 14 figs., 3 refs., 3 tabs.

15 GEOTHERMAL ENERGY

1503 Geothermal Exploration and Exploration Technology

30271 (DOE/ID/12756–1-Vol.2) **The Newcastle geothermal system, Iron County, Utah: Geology, hydrology, and conceptual model: Volume 2, Appendices.** Blackett, R.E. (Utah Geological and Mineral Survey, Salt Lake City, UT (USA)); Shubat, M.A.; Bishop, C.E.; Chapman, D.S.; Forster, C.B.; Schlinger, C.M. Utah Geological and Mineral Survey, Salt Lake City, UT (USA). Mar 1990. 95p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG07-88ID12756. Order Number DE90010575. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This appendix contains raw data used in the fault slip analysis. Data was collected from four sites, sites A through D. Minor fault slip measurements are listed for each site, and each row of data is one measurement. The index number is an arbitrary sequential number. Strike is the strike of the fault plane, measured in the northern hemisphere. Dip is the dip of the fault plane, which has two letters attached to the end showing the quadrant of the dip direction. Rake is the rake of the slickenside in the plane of the fault, which has two letters attached to the end showing the quadrant of the plunge direction of the rake. Sense is the sense of slip of the

fault: N = normal (rake > 45°), R = reverse (rake > 45°), D = dextral (rake < 45°), S = sinistral (rake < 45°). 37 figs., 19 tabs.

30272 (LA–11813-MS) **Transient natural convection in heated inclined tubes.** McEligot, D.M. (Westinghouse Electric Corp., Middletown, RI (USA). Oceanic Div.); Denbow, D.A.; Murphy, H.D. Los Alamos National Lab., NM (USA). May 1990. 60p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. Order Number DE90008217. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

To simulate natural convection flow patterns in directionally drilled wellbores, experiments and analyses were conducted for a circular tube with length-to-diameter (L/D) ratio of 36 at angles of 0°, 20°, and 35° from the vertical. The tube was heated at the bottom and cooled at the top, and the insulation was adjusted so that approximately one- to two-thirds of the power dissipated was transferred through the tube wall to the surroundings. An aqueous solution of polyvinyl alcohol was employed as the working fluid in order to obtain low Rayleigh numbers corresponding to conditions in geothermal wellbores. Results were primarily qualitative but were useful in providing insight into the phenomena occurring. Steady-state temperature distributions were measured for the three orientations and for several heating rates to demonstrate the effects of tube angle and Rayleigh number. transient measurements of the temperature distribution were obtained during cooling from a higher temperature without a heat source to calibrate the heat losses. With the electrical heat source, temporal data were taken during heating to examine the approach to steady state. Quasi-steady flow conditions were approached rapidly, but the overall time constant of the apparatus was of the order of one-third of a day. Predictions with the three-dimensional TEMPEST code were first tested by comparison with simple conduction analyses. Comparison with actual data showed good agreement of the predicted temperature levels for the maximum inclination, 35°, and slightly poorer agreement for the other limit, a vertical tube. Trends of temperature level and Nusselt number with heating rate or Rayleigh number were reasonable, but the predicted variation of the end Nusselt number versus inclination was in the opposite direction from the experiment. 75 refs., 20 figs., 8 tabs.

1508 Geothermal Power Plants

Refer also to citation(s) 30300

30273 (FRCEA-TH–248) **Medium energy geothermics and the up grading of natural hot water resources for electricity production through an organic fluid Rankine cycle: state of the art, technical and economical study.** Laplaige, P. Aix-Marseille-1 Univ., 13 - Marseille (France); CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-lez-Durance (France); Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 441p. (In French). Order Number DE90784614. Available from NTIS (US Sales Only), PC A19/MF A01.

The medium grade geothermal energy may be converted into useful energy through a new technology, the organic fluid Rankine cycle. It allows the valorization of small hot water resources (temperature ranging from 90 C to 150-200 C) with a power production rate from 500 KWe to ten Megawatts. The resources are evaluated, the technology and equipments are now well adapted and the economic feasability is assessed. An example in Alaska is described.

1509 Geothermal Engineering

Refer also to citation(s) 30299

16 TIDAL AND WAVE POWER

1601 Resources and Availability

30274 (ETSU-TID–4048-P1) **The UK potential for tidal energy from small estuaries.** Binnie and Partners, London (UK); Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 59p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Revised edition which supercedes ETSU-STP–40480P1.

The results of a survey of 118 small estuaries and embayments located on the West coast of England and Wales and the Western part of the Southern coast of England in relation to tidal power potential are presented. The approximate installed turbine capacity, energy output, capital cost and cost of energy are assessed for each site. Ten sites are considered in more detail. Over half of the 118 sites have a predicted cost of energy which could not be economic in the foreseeable future but a number of the sites could be developed to produce electricity at a unit cost of about 4p/KWh or less. (UK).

1605 Environmental Aspects

30275 (ETSU-TID–4070) **Prediction of marginal vegetation in a post-barrage environment: A model of Spartina anglica niche in south and west Britain.** Gray, A.J. (Furzebrooke Research Station, Wareham (GB)); Clarke, R.T.; Warman, E.A.; Johnson, P.J. Natural Environment Research Council, Cambridge (UK). Inst. of Terrestrial Ecology; Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 66p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report explores the problem of predicting changes in the marginal vegetation of estuaries following the construction of barrages for tidal power generation. It focuses on the development of simple multiple regression models of the distribution of a key species, Spartina anglica, in relation to variation in physical and tide-related factors. Data from 107 levelled line transects across salt marshes in 19 estuaries in south and west Britain (from Poole Harbour to Morecambe Bay) form the basis of the study. (author).

17 WIND ENERGY

Refer also to citation(s) 30509

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30280

30276 (NRC/E–TM-WE010) **Technical memorandum: Assessment of performance and cost-effectiveness of wind energy conversion systems.** Chappell, M.S.; Templin, R.J. National Research Council of Canada, Ottawa, ON (Canada). Div. of Energy. Oct 1984. 28p. (MICROLOG–90-02328). Available from PC National Research Council of Canada, Publication Sales and Distribution Office, Montreal Road, Ottawa, ON, CAN K1A 0R6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The cost-effectiveness of a wind energy conversion system (WECS) installation depends on many parameters and there are many different methodologies used to calculate it. This report outlines a simple procedure which takes account of most significant parameters, and presents discussion of their relative importance and sensitivities. The 4 major factors which govern the economics of wind energy installations are the wind regime at the site, the performance of the WECS, its installed cost, and the projected operational/economic scenario. Introduction of simplifying yet realistic approximations allows a convenient assessment technique for WECS cost-effectiveness to be developed and presented as a multi-parameter nomograph, which illustrates the sensitivities of most major parameters. Example cases are cited to demonstrate the techniques. 11 figs., 3 tabs.

1705 Environmental Aspects

30277 (TNO-TPD–823.087) **Evaluation of the brochure 'Windturbine noise'.** Van der Toorn, J.D. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. May 1989.

27p. (In Dutch). Order Number DE90767886. Available from NTIS (US Sales Only), PC A03/MF A01.

The brochure 'Windturbinegeluid' (Wind turbine noise) was compiled by Holland Windturbine in cooperation with Lichtveld, Buis and Partners. It contains simple formulas by which noise levels of the rotor, the nacelle of a wind turbine and of the total wind turbine can be calculated. Based on the measured data of four wind turbines the prediction value of the formulas has been verified as well as to what extent the effects of alterations in design and construction can be predicted by means of the formulas. It appears that the inaccuracy of the average noise level of wind turbines is larger than the authors of the brochure suggest (circa 7 dB(A) instead of 1). Also the inaccuracy of the calculated intensities of noise sources is larger than suggested. It has been concluded that the formulas are not very useful in taking measures to reduce noise from a wind turbine. 8 tabs., 4 apps., 10 refs.

1706 Wind Energy Engineering

Refer also to citation(s) 30276

30278 (ETSU-WN–1063) **Power enhancement of windmills by augmenters.** Garside, A.J.; McIntosh, A.C.; Munns, R.J. Cranfield Inst. of Tech., Bedford (UK). School of Mechanical Engineering; Department of Energy, London (UK); UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 103p. Available from the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

First published 1981.

The report describes, in detail, experiments carried out to demonstrate the principle of wind turbine augmentation using tipvanes. Under certain conditions, flow waisting is readily observed, confirming the findings of Delft University of Technology. The results indicate that power augmentation will only be achieved with certain critical combinations of tipvane configuration and power blade setting. In addition, the importance of maximizing the lift to drag ratio of the tipvane is highlighted. An automatic data gathering and analysis system has been developed and is described. It has proved invaluable for monitoring the tests and providing on-line data. (author).

30279 (SASKOIL–FP7) **Wind turbines for pumping oil: Final technical report.** Saskoil-Saskatchewan Oil and Gas Corp., Regina, SK (Canada). [1984]. 70p. (CE–02943). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The object of this project was to assess the technical and economic feasibility of utilizing wind turbine generators to produce electrical power for operating oil well pumpjack motors. Three Saskoil leases had wind monitoring equipment installed, which collected atmospheric data over a one year period. A review of commercially available wind turbine generators was conducted and using the atmospheric data, two different systems were designed, costed, and analyzed for techno-economic feasibility. System I uses a wind turbine generator to supply power in an attempt to reduce utility costs at a lease presently serviced by a utility network. System II uses a wind turbine generator to supply all the electrical power required to continuously operate a remote location lease which does not have utility power available. The wind system is compared to a remote lease which uses propane to power the pumpjack. The conclusions were as follows: the application of wind turbine generating systems to oil well pumping operations is not economically feasible at present; both wind power systems evaluated were technically feasible to construct and operate by using existing commercial equipment; the widespread use of wind power systems in the oilfield is unlikely due to factors such as unknown reliability in oil wellpumping situations, operational problems, and high operating costs. 10 figs, 9 tabs.

30280 (SE–5845-00-1-79) **Study of large wind-powered electric generators, phase 1: Hydro Quebec report.** Shawinigan Engineering Co. Ltd., Montreal, PQ (Canada). May 1979. vp. (CE–02926). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report bears on the first stage of the study, which was to assess the present technologies of large wind-powered generators and to examine the technical (aerodynamical, mechanical, electrical and structural) aspects of the existing or projected plants. The storage (short-term, medium-term, and long-term) of the produced energy is also discussed. The purpose of the study was to determine, from a literature survey, the types of machines that are more economical and better suited for being connected to a power network. A description of 21 existing large wind-powered generators in Europe and North America is included, as well as a discussion of 5 innovative concepts of wind turbines. The main conclusions of the study are the following: it was not possible to judge whether vertical-axis trubines or the more common horizontal-axis tubrines were more reliable or easier to maintain; large generators seem to be more economical, and are also more interesting from the point of view of the electric utilities; and, finally, for capacities of the order of 12 MW, the cost of the produced energy might be in the range 2 - 4 Canadian cents/kWh. It is recommended to undertake the second phase of the project, which will enable better comparisons between horizontal-and vertical-axis machines; it is also recommended to undertake complementary studies on the management of stocks of wind-powered generators, on their contrubution to power networks, and on the anemometry of Quebec Province. 118 refs., 55 figs., 34 tabs.

30281 (SE–5845-01-1-79) **Study of large wind-powered electric generators, phase 2: Hydro-Quebec report.** Shawinigan Engineering Co. Ltd., Montreal, PQ (Canada). Dec 1979. 75p. (CE–02924). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report bears on the second stage of the project, which is an in-depth technical comparison between horizontal-axis and vertical-axis machines. Wind-powered generators of American design (MOD-1, MOD-1A and MOD-2) and large vertical-axis wind-powered generators of Canadian design (24330 and variants) are compared from the aerodynamical, electrical, mechanical and structural points of view. The control systems, the environmental impacts (eletromagnetic perturbations, noise pollution, and the effects on wildlife), safety, and frosting are also discussed. The main conclusions of the study are the following: horizontal-axis and vertical-axis machines are equivalent, but the maintenance of vertical-axis machines is easier; horizontal- and vertical-axis rotors have approximately the same power capacity for equal swept areas and wind speeds, and the main factor of the comparison becomes the cost of the energy produced; the designs of the supports are different (self-bearing for horizontal-axis machines, greyed for vertical-axis machines); the electrical and mechanical equipment and the control instruments are similar for both types of machines; the environmental impacts are also similar; design improvements have resulted in important weight reductions for the vertical-axis machines, but similar improvements should be possible for the horizontal-axis machines too. It is recommended to proceed with an economical comparison between both types of machines. 24 refs., 28 figs., 20 tabs.

30282 (SERI/TP–257-3737) **A low-cost PC-based telemetry data-reduction system.** Simms, D.A.; Butterfield, C.P. Solar Energy Research Inst., Golden, CO (USA). Apr 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-9004110–1: 4. national conference on microcomputer applications in energy, Tucson, AZ (USA), 25-27 Apr 1990). Order Number DE90000330. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Solar Energy Research Institute's (SERI) Wind Research Branch is using Pulse Code Modulation (PCM) telemetry data-acquisition systems to study horizontal-axis wind turbines. PCM telemetry systems are used in test installations that require accurate multiple-channel measurements taken from a variety of different locations. SERI has found them ideal for use in tests requiring concurrent acquisition of data-reduction system to facilitate quick, in-the-field multiple-channel data analysis. Called the

"PC-PCM System," it consists of two basic components. First, AT-compatible hardware boards are used for decoding and combining PCM data streams. Up to four hardware boards can be installed in a single PC, which provides the capability to combine data from four PCM streams directly to PC disk or memory. Each stream can have up to 62 data channels. Second, a software package written for the DOS operating system was developed to simplify data-acquisition control and management. The software provides a quick, easy-to-use interface between the PC and PCM data streams. Called the "Quick-Look Data Management Program," it is a comprehensive menu-driven package used to organize, acquire, process, and display information from incoming PCM data streams. This paper describes both hardware and software aspects of the SERI PC-PCM system, concentrating on features that make it useful in an experiment test environment to quickly examine and verify incoming data. Also discussed are problems and techniques associated with PC-based telemetry data acquisition, processing, and real-time display. 9 refs., 3 figs., 4 tabs.

20 FOSSIL-FUELED POWER PLANTS

Refer also to citation(s) 30446

2001 Power Plants and Power Generation

Refer also to citation(s) 29993, 30026, 30027, 30313, 30315, 30607, 30654, 30657, 30660

30283 (BNL–44436) **Test report: Generator stator bar leak quantification and pinpointing.** Loss, W.M.; Dietz, R.N. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90010017. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tests to detect generator stator bar leaks were conducted at the Union Electric Labadie Power Plant during a two-day period in January. The stator bar assembly of the unit No. 4 generator was pressurized to 5 psi with nitrogen containing 300 ppm of PMCP (perfluoromethylcyclopentane). The presence of the tracer in the generator shell was discovered with passive samplers that were attached to stator bars on both ends of the assembly. The arrangement allowed the detection of areas of increased concentration necessary for subsequent pinpointing of leaks. Leak pinpointing was achieved by sampling air in these areas of higher concentration with the Dual Trap Analyzer. A second tracer, PMCH (perfluoromethylcyclohexane), contained in a l-liter cylinder with a known emission rate was used to quantify the leak rates from the stator bar assembly. The average leak rate was determined to be 50 liters/day (about 2 ft^3/day) at a nominal pressure of 100 psi. Investigation of several accessible leaks showed leak rates about 1000 times smaller than the overall leak rate. Hence, none of the leaks in the upper accessible half of the generator shell was the major leak. 1 fig., 2 tabs.

30284 (CONF-8810352–, pp. 51-83) **Power plant structural materials testing methods (CISE, Italy, test facility).** Caruso, E. (CISE, Milan (Italy)); Fossati, C.; Pascali, R. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

In this paper, the testing methods carried out by the CISE Laboratories (Italy) for power plant structural materials characterization, are described. In particular, the testing methods to verify corrosion resistance static and dynamic fracture toughness characteristics, tensile properties, mechanical properties (creep), electrochemical characteristics, wear resistance, etc., are reviewed.

30285 (DOE/ET/10815–142) **The MHD/steam combined cycle power plant: A technology update.** Johanson, N.R.; Attig, R.C.; Chapman, J.N. Tennessee Univ., Tullahoma, TN (USA). Space Inst. [1990]. 8p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-79ET10815. (CONF-9004133–1: American power conference, Chicago, IL (USA), 23-25 Apr 1990). Order Number DE90009967. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The MHD/steam combined cycle power plant concept involves burning fossil fuel at high temperatures (~5000 F), generating power with an MHD generator from the high temperature exhaust products and using a steam plant for conversion of the remaining thermal energy to electricity. The MHD portion is called the topping cycle and the steam plant is called the bottoming cycle. The system uses potassium seed, burned with coal and preheated and/or oxygen enriched air to achieve temperatures sufficient to provide some electrical conductivity in the combustion products by thermal ionization of the potassium atoms. conversion efficiency of the MHD generator is much higher that a steam cycle, typically 85–90%. The appeal of the combined cycle plant is much higher overall plant efficiency than other known technologies (up to about 55% in the mature plant), inherent control of SO2, NOx and particulates. SO2 can be reduced to a few parts per billion if desired and NOx can be reduced to 15–20% of current New Source Performance Standards. The purpose of this paper is to report the current status of development of the technology needed for the commercialization of plants using this concept. 9 refs., 11 figs.

30286 (DOE/MC/23077–2800) **Assessment of modular IGCC [integrated gasification combined cycle] plants based on entrained flow coal gasification.** Fu, R.K. Foster Wheeler USA Corp., Clinton, NJ (USA). Jun 1989. 130p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23077. Order Number DE90000456. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

An assessment of modular integrated gasification combined cycle (IGCC) power plants, based on Texaco entrained flow gasification, having a nominal capacity of 100 megawatts was conducted by Foster Wheeler. The scope of this study consisted of developing preliminary designs and relative economics for five modular IGCC power plant configurations in an effort to compare the use of air or oxygen as the oxidant for coal gasification and high temperature or low temperature processes for gas cleanup. Conceptual designs were prepared based on non-confidential information, estimated capital and operating costs, and determined the cost of electricity for five different modular IGCC plant configurations. In all five plant configurations, the same gas turbine, which is commercially available for conventional fuels, was used. It was assumed that this commercially available gas turbine could be modified without additional cost impact to accept the hot low BTU fuel gas produced from air gasification with high temperature cleanup. 16 refs.

30287 (EPRI-GS–6393) **Development and application of the Coal Quality Impact Model: CQIM™: Final report.** Davidson, P.G.; Galluzzo, N.G.; Stallard, G.S.; Jennison, K.D.; Brown, R.E.; Jonas, T.S.; Pavlish, J.H.; Mitas, D.W.; Lowe, D.A.; Arroyo, J.A. Electric Power Research Inst., Palo Alto, CA (USA); Black and Veatch, Kansas City, MO (USA). c Apr 1990. 175p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Utilities frequently evaluate the use of alternate coals at existing power generating plants in an attempt to reduce fuel costs and meet changing air quality emission limitations. Utility personnel evaluate delivered coal costs and, in some instances, the performance and cost impacts of changes in coal quality. Performance impact include loss of spare equipment, plant heat rate impacts, auxiliary power changes, consumable requirements, waste generation, unit derates, and forced outage changes. Cost impacts include costs for replacement power, equipment maintenance, consumables, and waste disposal. This report describes the development and initial application of a state-of-the-art computerized Coal Quality Impact Model (CQIM™) capable of predicting performance and cost impacts of burning alternative coals at existing power generating plants. The CQIM is an easy-to-use, comprehensive model designed to cater to both sophisticated users and those with little engineering background. The program uses equipment-specific models and can be fine-tuned to reflect operation,

maintenance, and availability specific to the power generating unit under evaluation. 17 figs., 55 tabs.

30288 (EPRI-GS–6788) **Steam turbine maintenance and repair technology: Reducing planned-outage costs: Final report.** Grace, H.P. (General Physics Corp., Columbia, MD (USA)); McClintock, M.; Lamping, G. Electric Power Research Inst., Palo Alto, CA (USA); General Physics Corp., Columbia, MD (USA); Southwest Research Inst., San Antonio, TX (USA). c Apr 1990. 203p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The North American Electric Reliability Council (NAERC) reported that the average loss of equivalent availability per outage for a major fossil turbine overhaul is 323,000 MW-HR. The Electric Power Research Institute (EPRI) Generation and Storage Division, is in the first phase of a major research project to reduce the duration and/or frequency of steam turbine maintenance outages. This project consists of an assessment of the current state-of-the-art turbine maintenance and repair techniques and technologies. It is based on a review of current turbine maintenance practices of the US, European, Japanese, and Australian utility industries. Emphasized are maintenance and repair activities that have the most significant impact on outage duration or frequency. Twenty-six key turbine maintenance activities and the current best techniques were identified for use by utility maintenance personnel. Overall outage durations could be reduced if the duration of these activities were shortened or if they were performed more effectively. Recommended projects for development of advanced steam turbine maintenance technology were identified. 29 refs., 46 figs., 9 tabs.

30289 (EPRI-GS–6826) **Materials tests at the PRENFLO coal gasification plant: Final report.** Koehnen, K. (Gesellschaft fuer Kohle-Technologie mbH, Essen (Germany, F.R.)); Ullrich, N.; Bakker, W.T. Electric Power Research Inst., Palo Alto, CA (USA); Gesellschaft fuer Kohle-Technologie mbH, Essen (Germany, F.R.). c Apr 1990. 120p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report evaluates the behavior of tube materials tested in the PRENFLO coal gasification plant. The tests were conducted in the PRENFLO demonstration plant at Fuerstenhausen, Federal Republic of Germany. Some of the alloys were supplied by EPRI and some by GKT. The alloys were tested for more than 2000 operating hours as steam superheater tubes and isothermally in the form of prestressed tensile bars and U-bends. Thickness loss measurements and microscopic evaluation of the superheater tubes indicate that the low alloy ferritic steels (< 9 % Cr) are only suitable for use at temperatures below 400 °C (752 °F), if provisions are made to replace or repair the heat exchanger tubes every 2–5 years. Sanicro 28 and coextruded SS 310/T 11 tubes promise long-term service in evaporator elements with steam pressures up to 138 bar (2000 psi). Isothermal exposure of austenitic prestressed tensile bars and U-bend coupons did not reveal any stress corrosion cracking or other signs of downtime corrosion. 66 figs., 20 tabs.

30290 (KEMA–88-431) **The preconnection of a closed gas turbine cycle in a coal-fired electric power plant.** Koetzier, H.; Peppink, G. Keuring van Elektrotechnische Materialen NV, Arnhem (Netherlands). Werktuigbouwkundig Projekten Bureau. May 1988. 71p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

The preconnection of a closed gas turbine (i.e. a Brayton cycle) in a conventional pulverized coal fired power plant has been investigated. A maximum temperature of 1000 C of the medium helium in the Brayton cycle can be realized, making the assumption that in the future materials will be available which will not creep at 1150 C. For a not yet optimized connection the efficiency can be improved by circa 1.5%-points compared to a conventional pulverized coal-fired plant. For the present materials efficiency improvement is too low to justify the extra investments. In case of creep resistant materials (at 1150 C) the investigation can be continued to study the constructive aspects and optimization of the connection. 9 figs., 4 refs., 7 tabs., 3 apps.

30291 (KEMA–88-602) **COHESION: The preconnection of a helium cycle in a coal-fired electric power plant.** 't Hart, A.; Peppink, G. Keuring van Elektrotechnische Materialen NV, Arnhem (Netherlands). Werktuigbouwkundig Projekten Bureau. Jul 1988. 14p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

The results of a series of process calculations for a coal helium steam in one utility (COHESION) are presented. The system can be compared with a mixed pressure STEG-unit (steam turbine in combination with a gas turbine). The gas turbine working fluid, however, is helium heated to the desired turbine inlet temperature by means of pulverized coal combustion. Taking into account future material developments for which helium can be heated to 1300 C, gross efficiencies of circa 47% can be realized. A more detailed study of the process is recommended. 2 figs., 1 ref.

30292 (KEMA–70196-WPB-88-375) **Water injection in a recuperated gas turbine.** Peppink, G. Keuring van Electrotechnische Materialen NV, Arnhem (Netherlands). Apr 1988. 21p. (In Dutch). Available from NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands.

Results are given of a series process calculations for a gasturbine equipped with a recuperator and water injection in the combustion air. The system has been calculated for three gas turbine temperatures, six compression ratios and seven water fractions. Also the advantage of a bottoming cycle in the system is considered. From the calculations it appears that by means of the water injections a very simple circuit is created, which equals the efficiency of a STEG (combined steam- and gas turbines). Even better efficiencies can be realized by using a bottoming cycle. It can also be concluded that the process is extremely appropriate for cheap, gas-fueled, medium-load, high-efficiency units. 12 figs., 4 refs., 1 app.

30293 (PB–90-178096/XAB) **Private-sector power generation in Indonesia: Opportunities and impediments.** Palmedo, P.F.; Amin-Arsala, B.; Bagdon, M.; Eveleth, S.; Faulkner, M. Energy/Development International, Washington, DC (USA). Mar 1988. 173p. Available from NTIS, PC A08/MF A01.

The report assesses the potential for and implications of private power production in Indonesia and recommends government actions to further encourage private power. Background information is provided on the current state of electric power in Indonesia and experiences with private power in the United States, Turkey, and Pakistan. Three general approaches to private power production are assessed: new, large-scale power plants based on indigenous coal or natural gas; cogeneration in industry; and biomass/renewable energy systems. Technical, financial, and development aspects of each approach are discussed. Indonesia's financial and investment climate for power privatization is described. The report then proposes a framework for government actions. According to the study, private power production could be of significant benefit to Indonesia if properly managed and planned. Benefits would include an increase in the overall energy and economic efficiency of the power system; reduction in local currency and foreign exchange burdens; and accelerated rural electrification.

30294 (PB–90-178740/XAB) **Performance diagnostics software for gas turbines in pipeline and cogeneration applications. Final report, July 1985-September 1989.** Levine, P. Fern Engineering, Inc., Pocasset, MA (USA). Dec 1989. 41p. Available from NTIS, PC A03/MF A01.

The development experience for the PEGASYS and COGENT software is presented. The PEGASYS software is applicable to two-shaft gas turbines in simple, regenerative and combined cycle systems. The COGENT software is applicable to cogeneration systems. The test results show that the software is able to define the deviations between measured and expected power and thermal efficiency. Further, the software is able to identify the components causing the performance losses. The results show that axial compressor fouling is a major cause of performance losses and that the performance can be recovered by washing. A description of an on-line version of PEGASYS is described.

30295 (PB–90-501339/XAB) **Steam-electric plant operation and design report (EIA-767) extract data tape, (1985-1987). Data file.** Pechan, E.H.; Masser, C.C. Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab. 1987. mag ta Available from NTISCP T03.

Source tape is in the EBCDIC character set. This restricts preparation to 9 track, one-half inch tape only. Identify recording mode by specifying density only. For price at 6250 bpi density, call NTIS Computer Products. Price includes documentation, PB–90-165879.

Over the past several years, the U.S. Environmental Protection Agency (EPA), through the Air and Energy Engineering Research Laboratory (AEERL) has been a major sponsor of the Energy Information Administration's (EIA) Form 767 data collection effort. The Form EIA-767, entitled Steam-Electric Plant Operation and Design Report is an annual data collection form whose major output to-date has been an annual data tape which is released to the public through the National Technical Information Service. The output from the study included in the report is a one-page-per-plant report which includes a variety of information extracted from various parts of the Form EIA-767. For each applicable plant, several categories of information were extracted and included: plant ownership, identification, and location information; boiler design characteristics; pollution control equipment design characteristics; fossil fuels consumed and their quality for 1985; fossil fuels consumed and their quality for 1986; and fossil fuels consumed and their quality for 1987.

30296 (PB–90-780362/XAB) **FAA (Federal Aviation Administration) academy correspondence study: Diesel engine generators. (Second edition).** Federal Aviation Administration, Washington, DC (USA). Office of Training and Higher Education. Mar 1989. 283p. Available from NTIS, PC A13/MF A02.

Errata sheet inserted.

The course is designed for self study of basic principles, concepts, terminology and definitions of diesel engine generators and associated control panels. The course consists of four chapters. There is a lesson examination for each chapter and a final examination at the end of the course. Each chapter is divided into sections and practice problems follow many of these sections so that for self study an entire chapter can be read and all practice problems worked before starting a lesson examination.

30297 Development and application of an extractive alkali monitor and its sampling system for process stream analysis. Wachter, J.K. (U.S. Department of Energy, Morgantown Energy Technology Center, Morgantown, WV (US)); Logan, R.G.; Pineault, R.L. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1414.

Alkali concentrations (sodium and potassium) in combustion streams are important to asses due to their role in promoting corrosion on turbine components. This paper reports how, in order to acquire real-time, on-line transient alkali data, a fiber-optic alkali monitor (FOAM) utilizing state-of-the-art fiber optic light transfer, a light-filtering background correction method, and high-sensitivity photodiode signal detection has been developed and tested. An extracted sample enters the monitor's high-temperature nitrous oxide/acetylene flame, which supplies energy to both decompose particles/aerosols and excite the alkalis present. The center portion of the flame then emits light at the characteristic wavelengths of sodium and potassium. The resulting emissions are transferred via a bifurcated fiber optic bundle (one branch for sodium detection, the other for potassium) to the detection system, where the signal from each branch is pre-filtered (to prevent unwanted flame radiation from reaching the detectors). The signal is then divided by beam splitters to a foreground (analytical) and background subchannel and filtered using dichroic interference filters centered on a particular alkali emission line (589 nm for Na channel; 766.5 nm for K), with each having different bandwidths (3 nm for analytical channel; 10 nm for background channel). Using a background correction technique based on this two-filter/different bandpass configuration, a signal that is solely due to the intensity of the desired emission line can be extracted from the background signal.

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Refer also to citation(s) 29974, 29981, 29983, 29990, 29993, 30285, 30286, 30573

30298 (CONF-900381–1) **Identification of materials for hot-gas filter tubesheets.** Swindeman, R.W. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From Heat engines and gas stream cleanup contractors review; Morgantown, WV (USA); 26-28 Mar 1990. Order Number DE90008855. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The DOE Morgantown Energy Technology Center (METC) is developing hot gas cleanup techniques for better environmental performance of pressurized fluidized bed combustors (PFBC) and gasifiers. Objectives of this work are to evaluate current tubesheet designs and materials selection for the support of ceramic filters, assess alternative designs, collect materials design data, and recommend a tubesheet material and design methodology for high temperature service. Literature data were collected and the alloys were evaluated on the basis of availability, strength, fabricability, corrosion resistance, and the extent of the data base. The candidate alloys were RA333, Haynes 556, and HK-40. 5 refs., 8 figs.

30299 (CONF-8810352–, pp. 29-50) **Materials and innovative technologies for use in power plants.** Regis, V. (ENEL, Centro Ricerca Termica e Nucleare, Milan (Italy)); D'Angelo, D. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper describes ENEL (Italian Electricity Board) research activities relative to fossil-fuel power plant steels and alloys for components operating in high temperature, highly corrosive environments and to equipment for the abatement and control of sulfur and nitrogen oxide emissions. Research work in the area of structural materials for geothermal power plants is also mentioned with emphasis given to progress being made in the development of materials with a high level of resistance to wear and stress corrosion.

30300 (CONF-8810352–, pp. 115-125) **The use of titanium in pollution control equipment in fossil-fuel and geothermal plants.** Ginatta, M.V.; Debernardi, E. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

In this study on the use of titanium and its alloys in electric and geothermal power plant flue gas desulfurization systems, the main reasons for their use and the particular corrosion resistance of these materials are examined. Comparative data are tabled indicating the corrosion performance of different titanium alloys after nine months exposure in the outled duct reheat zone of a closed loop scrubber and an analysis is made of the efficacy of inhibitors in improving corrosion resistance.

30301 (CONF-8810352–, pp. 181-195) **Power plant desulfurization system components: Materials, quality control, design philosophies.** Livraghi, M. (ENEL, Direzione delle Costruzioni, Rome (Italy)). ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting*

organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988. Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

Within the realm of its environmental protection programs, ENEL (Italian Electricity Board) has adopted flue gas desulfurization systems for its new poly-fuel power plants. The severe operating conditions determined by the presence of highly corrosive gaseous wastes and abrasive suspended particulates require accurate choices of materials and fabrication and assembly controls for these systems in order to lessen future maintenance impacts. This paper discusses ENEL's design philosophies relative to materials selectioning and quality control criteria with reference to past experience.

30302 (DOE/PC/79854–T2) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly report, February–April 1987.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. 24 Mar 1988. 11p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010009. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research continued on the development of electrochemical membranes for SO_x removal from flue gas. Work in this period concerned designing and testing a new cell which would pre-oxidize the majority of the inlet sulfur dioxide. Previous free electrolyte studies in our lab showed that the oxidation of SO_2 to SO_3 is a key step in the electrochemical removal of SO_2. Although vanadia, as an electrolyte additive, enhanced oxidation, the geometry of the removal cells limited the overall conversion to unacceptably low values. To eliminate the conversion problem, the SO_2 will be oxidized in a simple reactor unit just prior to the electrochemical removal cells. The catalyst chosen to promote the reaction is platinum dispersed on a porous, inert support. This catalyst is reported in literature as the most active toward the oxidation. Two types of inert supports were investigated, alumina and silica gel. 1 fig., 5 tabs.

30303 (DOE/PC/79854–T3) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly report, [May 20–August 20, 1987].** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. 2 Sep 1987. 30p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010022. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research continued on the development of electrochemical membranes for SO_x removal from flue gas. Work for the period of May 20 to August 20, 1987 focused on three aspects of the project. The three areas investigated were: (1) SO_x removal in free electrolyte; (2) NO_x removal in free electrolyte; and (3) fabrication of perovskite ($La_{0.8}Sr_{0.2}CoO_3$) electrodes. 3 figs., 18 tabs.

30304 (DOE/PC/79854–T4) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly report, August–October 1987.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. 21 Mar 1988. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010023. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research continued on the use of electrochemical membranes for SO_x removal from flue gas. Work for this period focused on the development of the perovskite ($La_{0.8}Sr_{0.2}CoO_3$) electrodes. The fabrication procedure which produced the most superior electrodes included; (1) decomposing the precursor metal acetates at 500°C; (2) grind to a particle size of approximately 60–120 microns; (3) press particles into a disc at 20 to 40 kg/cm^2; and (4) sinter disc between 1100 C and 1200°C. The capabilities of the perovskite electrodes were examined by comparing their performance to nickel oxide electrodes in a molten carbonate membrane cell. The molten carbonate/nickel oxide cell has been characterized in great detail through fuel cell research. The polarization behavior of this cell is well known and was used as a gage to compare and assess the performance of perovskite electrodes in this cell. 2 figs., 1 tab.

30305 (DOE/PC/79854–T5) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly progress report, [November 20, 1987–February 20, 1988].** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. [1990]. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010024. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research continued on the use of electrochemical membranes to remove SO_x from flue gas. This quarter research focused on three aspects of the process; (1) membrane development; (2) electrode development; and (3) testing performance of the electrochemical cell. The majority of work conducted on the membrane was with MgO as the matrix material. In the area of electrode development, perovskite electrodes were investigated with regard to: (1) structure; and (2) performance as compared to NiO commercial electrodes. The mechanism of SO_2 removal, and reaction kinetics, is also discussed. 3 refs., 9 figs., 1 tab.

30306 (DOE/PC/79854–T7) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly progress report, June 20–September 30, 1988.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. [1990]. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010026. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Research continued on electrochemical membrane removal of SO_x from flue gas. During the quarter from June 20, 1988 to September 30, 1988 research focused on three areas. The first major area is the replacement of the platinum-on-silica-gel pre-oxidation catalyst. This involved solving an analysis problem and generating conversion v. flow rate v. temperature data. The second major area is the improved ceramic membrane; this included melting point studies and the development of a new fabrication technique. The third area is the testing of one of the improved ceramic membranes. This study was completed without the pre-oxidation catalyst to determine the effectiveness of a 5 wt % vanadia electrolyte. 5 figs., 4 tabs.

30307 (DOE/PC/79854–T9) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly progress report, January 1–March 31, 1989.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. [1990]. 23p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010028. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Work continued on the development of electrochemical membrane materials for SO_x removal from flue gas. Materials investigated/fabricated include: borosilicate glass, MgO, silicalite (SiO_2:Al_2O_3), 3 zeolites, cab-o-sil, corning 7740 (ball milled glass), and LUDOX AS-40 (SiO_2:NH_3 = 270). A membrane was investigated for use in NO_x removal which contained 1% TiO_2 and 1% $FeSO_4$ with 5% V_2O_5, $K_2S_2O_7$ and borosilicate particles. (CBS)

30308 (DOE/PC/79854–T10) **[Combined SO_x, NO_x removal and concentration from flue gas through an electrochemical membrane]: Quarterly progress report, March 1–May 31, 1989.** Winnick, J. Georgia Inst. of Tech., Atlanta, GA (USA). School of Chemical Engineering. [1990]. 27p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79854. Order Number DE90010029. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Studies on electrochemical membrane removal of SO_2 from flue gas continued. During this quarter, research has stressed preparation of new formulations of electrochemical membranes. Various membrane matrix materials have been investigated as replacements for the MgO of previous work. Several of these formulations have been tested in the full cell. Emphasis here was on characterizing the improvements in the overpotential behavior of both electrodes. Several membrane were fabricated during the quarter. The matrix materials included borosilicate glass particles, amorphous silica particles derived from an aqueous suspension, Silicalite (a type of zeolite), and a porous glass membrane disc. Also the effect of new membrane formulations on the overpotential of the cell was studied. 14 figs.

30309 (OH/RD–89-95-K) **Stability of the long-term fly ash mound at the Nanticoke TGS [thermal generating station] lagoon.** Lau, K.C.; Chan, H.T. Ontario Hydro Research Div., Toronto, ON (Canada). 9 May 1989. 47p. (MICROLOG–90-00405). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

The stability of four slope sections of the proposed long-term fly ash disposal mound at the Nanticoke (Ontario) coal-fired power station site was analyzed. The phreatic surface location used in this study was calculated by the analytical model developed in a previous study. It has been found that the factor of safety of the slope is very sensitive to the location of the phreatic surface used in the analysis. Results of this study indicate that no major slope failure is anticipated. A parametric study on the effect of the phreatic surface location within the ash mound and of the shear strength of the ash on the stability of the slopes was carried out. The results of this parametric study have provided a better ash mound at the Nanticoke site. Recommendations are made with respect to vegetative stabilization, interceptive drainage, and erosion protection. 5 refs., 35 figs., 4 tabs.

30310 (OH/RD–89-229-K) **Geotechnical considerations for the design of the extended fly ash mound at Nanticoke TGS [thermal generating station].** Lau, K.C.; Chan, H.T. Ontario Hydro Research Div., Toronto, ON (Canada). 26 Sep 1989. 46p. (MICROLOG–90-00423). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

By switching from the currently used wet ash deposal method to a dry ash disposal method at the Nanticoke (Ontario) coal-fired power plant, the areas where the existing ash settling cells and part of the primary lagoon are located, can be reclaimed and used for future ash storage. This conversion in the ash disposal method will increase the ash storage capacity of the existing facility by about 70%, which is equivalent to an additional storage life of 9.5 years. In this report, a conceptual design for the proposed extension of the existing ash storage mound to be located on the reclaimed area is presented. In this design, the advantage of stage construction is fully utilized. The performance of the ash storage mound constructed during two stages of the project will be monitored and the results will be used to ensure the performance of the future ash storage mound. 4 refs., 29 figs., 1 tab.

30311 (PB–90-861402/XAB) **Electrostatic precipitators. September 1979-January 1990 (a Bibliography from the COMPENDEX data base). Report for September 1979-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 112p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning worldwide literature on electrostatic precipitators for air pollution control. Articles cited cover the design, performance, theory, installation methods, and principal applications. Economic evaluation and comparisons with other particulate removal systems are included. Filtration, particle collection, and ventilation are subjects covered in related published bibliographies. (Contains 247 citations fully indexed and including a title list.)

30312 (PB–90-861519/XAB) **Electrostatic precipitators. June 1971-October 1989 (a Bibliography from the US Patent data base). Report for June 1971-October 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 119p. Available from NTISPC N01/MF N01.

This bibliography contains citations of selected patents concerning electrostatic precipitators, components, and control methods. Included are power control systems, precipitator designs, rappers, air cleaning systems, discharge electrodes, configuration designs, washer systems, collection systems, and other peripheral components of electrostatic precipitators or systems incorporating them. Particle collection, sampling, and size analysis are referenced in related published bibliographies. (Contains 279 citations fully indexed and including a title list.)

30313 **A slagging combustor for direct coal-fired gas turbines.** Diehl, R.C. (Avco-Everett Research Lab., Everett, MA (USA)); Loftus, P.J.; Kozak, A.A.; Stickler, D.B.; Bannister, R.L.; Pillsbury, P.W. pp. 1266 of Proceedings of the sixth annual international Pittsburgh coal conference. Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890916–: 6. annual international Pittsburgh coal conference, Pittsburgh, PA (USA), 25-29 Sep 1989).

This paper describes a Department of Energy sponsored program to develop the technology base for an advanced direct coal-fired gas turbine system for utility power generation. The approach under investigation is based on a multi-stage, slagging combustor, which incorporates NO_x, SO_x and particulate emissions control. This approach allows raw utility grade coal to be burned, thus maintaining a low fuel cost. The cost of electricity from combined cycle plants incorporating a direct coal-fired gas turbine is expected to be significantly lower than that from conventional pulverized coal steam plants with flue gas desulfurization.

30314 **Contractor/filter improvements.** Stelman, D To Dept. of Energy, Washington, DC. USA Patent 4880608/A/. 14 Nov 1989. Filed date 30 Jun 1988. USA Patent Application 7-213,798. Int. Cl. B01J 8/00. 12p. AC33-83PC60262.

The patent describes an improved contractor/filter arrangement for removing particulate contaminants from a gaseous stream. It includes a housing having a substantially vertically oriented granular material retention member with upstream and downstream faces, a substantially vertically oriented microporous gas filter element, wherein the retention member and the filter element are spaced apart to provide a zone for the passage of granular material therethrough. The housing further includes a gas inlet means, a gas outlet means, and means for moving a body of granular material through the zone. A gaseous stream containing particulate contaminants passes through the gas inlet means as well as through the upstream face of the granular material retention member, passing through the retention member, the body of granular material, the microporous gas filter element, exiting out of the gas outlet means. Disposed on the upstream face of the filter element is a cover screen which isolates the filter element from contact with the moving granular bed and collects a portion of the particulates so as to form a dust cake having openings small enough to exclude the granular material, yet large enough to receive the dust particles.

30315 **Nox control for high nitric oxide concentration flows through combustion-driven reduction.** Yeh, J.T.; Ekmann, J.M.; Pennline, H.W.; Drummond, C.J. To Dept. of Energy, Washington, DC. USA Patent 4878442/A/. 31 Oct 1989. Filed date 17 Jun 1988. USA Patent Application 7-207,995. Int. Cl. F23J 11/00. 6p.

This patent describes an improved method for removing nitrogen oxides from concentrated waste gas streams, in which nitrogen oxides are ignited with a carbonaceous material in the presence of substoichiometric quantities of a primary oxidant, such as air. Additionally, reductants may be ignited along with the nitrogen oxides, carbonaceous material and primary oxidant to achieve greater reduction of nitrogen oxides. A scrubber and regeneration system may also be included to generate a concentrated stream of nitrogen oxides from flue gases for reduction using this method.

2005 Environmental Aspects

Refer also to citation(s) 30287, 31351

30316 (OE–90-02012) **Terrestrial and atmospheric deposition studies in the vicinity of the Ontario Hydro thermal generating station, Atikokan, 1986.** Racette, D.J.; Griffin, H.D. Ontario Ministry of the Environment, Toronto, ON (Canada). Jan 1989. 20p. (MICROLOG–90-02012). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In 1981, the Ontario Ministry of the Environment began terrestrial and atmospheric deposition monitoring around a thermal generating station under construction near the Town of Atikokan in

northwestern Ontario. The power plant is owned by Ontario Hydro, comprises a single 200 MW unit fueled with low-sulphur lignite from western Canada and was commissioned in late 1985. This report summarizes terrestrial and deposition data obtained during the first year of plant operation in 1986 when the station was on a basic operating schedule of 16 hours/day, 5 days/week, with brief outages during the first months of the year and a maintenance shutdown from mid-June to mid-August. Chemical analysis of tree foliage, exposed moss, precipitation and snow demonstrated that current atmospheric concentrations of all measured parameters in were low and well within normal background ranges. The studies provided no evidence of measureable impact on the terrestrial environment resulting from operation of the power plant. Assessment surveys will continue at least until the end of 1988. 7 refs., 2 figs., 8 tabs.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30011, 30286, 30287, 30313

30317 (ORNL/FTR–3594) **[Design of the Fuel Evaluation Test Facility for the characterization of Indian coals]: Foreign trip report, March 3–April 5, 1990.** Krishnan, R.P. Oak Ridge National Lab., TN (USA). 20 Apr 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010011. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The travel was undertaken at the request of the Pittsburgh Energy Technology Center (PETC), US Department of Energy (US-DOE), to meet with Bharat Heavy Electricals Ltd. (BHEL), Trichy, India to (1) finalize the design of the Fuel Evaluation Test Facility (FETF) to be constructed at BHEL, Trichy, (2) establish a schedule for testing an Indian coal in the PETC Fuel evaluation Test Facility, and (3) coordinate the site visits to Indian thermal power stations and R&D institutions for the US power plant life expectancy project team. These activities are sponsored under the coal component of the Alternate Energy Resources Development (AERD) project of the US Agency for International Development (USAID). The PETC has the management responsibility for the coal projects, and the Oak Ridge national Laboratory (ORNL) is providing technical support to the BHEL and the Tata Energy Research Institute (TERI), the collaborating Indian institutions for these projects.

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 30372

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 30122, 30334, 30344, 30345, 30363, 30366, 30374, 30379, 30383, 30384, 30385, 30386, 30388, 30389, 30390, 30391, 30392, 30393, 30394, 30395, 30396, 30397, 30398, 30400, 30401, 30402, 30403, 30404, 30405, 30407, 30408, 30409, 30410, 30411, 30412, 30413, 30420, 30673, 30674

30318 (CONF-900617–11) **Thermal aging of cast stainless steels: Mechanisms and predictions.** Chopra, O.K. Argonne National Lab., IL (USA). Jan 1990. 40p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90010093. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Charpy-impact, tensile, and J-R curve data are presented for several experimental and commercial heats, as well as for reactor-aged material of CF-3, CF-8, and CF-8M grades of cast stainless steel. The effects of material variables on the embrittlement of cast stainless steels are evaluated. In general, the low-carbon CF-3 grades of cast stainless steels are the most resistant, and the molybdenum-containing high-carbon CF-8M grades are the most susceptible, to low-temperature embrittlement. While ferrite morphology has a strong effect on the extent or degree of embrittlement, material composition influences the kinetics of embrittlement, which can vary significantly with small changes in the constituent elements of the cast material. The mechanisms of embrittlement have also been established. Mechanical-property data have been analyzed to develop the procedure and correlations for predicting the kinetics and extent of embrittlement of reactor components from known material parameters. The method and examples of estimating the impact strength and fracture toughness of cast stainless steel components during reactor service are described. The lower-bound values of impact strength and fracture toughness for cast stainless steels at LWR operating temperatures are defined. 32 refs., 27 figs., 3 tabs.

30319 (DOE/ER/40475–2) **Measurement of uranium and plutonium content in a fuel assembly using the RPI spent fuel assay device.** Harris, D.R.; Rodriguez-Vera, F.; Abdurrahman, N.; Lee, Y.-D.; Slovacek, R.E.; Block, R.C. Rensselaer Polytechnic Inst., Troy, NY (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40475;FG07-88ER12823. (CONF-900608–15: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90010049. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper we report measurements of the significant parameters, the sensitivities of the slowing-down-time assay device to the fissile contents of a boiling water reactor (BWR) assembly mock-up of fresh fuel.

30320 (DOE/NE/34122–1) **SUPER-RAMP EXTENSION project: Final report.** Djurle, S. Studsvik Energiteknik AB, Nykoeping (Sweden). May 1990. 224p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG01-84NE34122. Order Number DE90009324. Available from NTIS (US Sales Only), PC A10/MF A01 - OSTI; GPO Dep.

Extending average fuel discharge burnups will improve fuel economics and reduce spent fuel volume. In order to justify an increase from the current burnup levels, sufficient experience and data must be obtained on fuel performance, especially during conditions that might be limiting for high burnup operations. The SUPER-RAMP (SR) project was one in a series of projects organized by STUDSVIK, had the principal purpose to investigate experimentally the pellet clad interaction (PCI) behavior and failure propensity of standard type LWR high burnup test fuel by means of power ramp tests in the STUDSVIK R2 reactor. The SR project showed a need for further study of certain important findings within the SR project and that led to a continuation of the project, in the form of the SUPER-RAMP EXTENSION (SRX) project. The SRX project, which was co-sponsored by 23 contracting organizations and managed by STUDSVIK ENERGITEKNIK AB, Sweden, started in 1984 and was completed in 1986. This document discussed the objectives and findings of the project. 2 refs., 91 figs., 24 tabs.

30321 (EPRI-NP–6730) **Effects of LOMI [low oxidation state metal ion] decontamination and preoxidation processes on stainless steel-clad low-alloy steel: Final report.** Wang, M.T. (General Electric Co., San Jose, CA (USA). Nuclear Energy Div.). Electric Power Research Inst., Palo Alto, CA (USA); General Electric Co., San Jose, CA (USA). Nuclear Energy Div. c Mar 1990. 49p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Standard 1T WOL (wedge opening load) bolt-loaded specimens were fabricated from a heat of SA302 Gr B low alloy steel and clad with 308L stainless steel. This quenched and tempered SA302 Gr B steel possesses a bainitic microstructure and is one of the key steels for boiling water reactor (BWR) pressure vessel fabrication. Fatigue precracks were produced which passed through the 308L clad layer into low alloy steel. This through-clad precracking, together with the galvanic coupling of austenitic and ferritic steels, is considered to be the worst condition for the stress corrosion cracking of the reactor pressure vessel (RPV) wall. The precracked specimens were loaded to an applied stress intensity of approximately 45 ksi $(in.)^{1/2}$. Scanning electron microscopy (SEM) and optical metallographic examinations revealed both intergranular (IGSCC) and transgranular (TGSCC) branched stress corrosion cracks beyond the tip of fatigue precracks in the Peach Bottom 3 in-plant LOMI/NP/LOMI exposed specimens. The low temperature BWR water autoclave immersion test was performed to simulate

the time/temperature cycle of the Peach Bottom 3 in-plant decontamination process but without addition of any decontamination solvents. Results of this study also indicated that the NP/LOMI process tended to promote stress corrosion crack propagation in the pressure vessel low alloy steel. Although the degree of susceptibility and crack morphology may depend on process time, temperature, and solvent concentration, it appears that nitric acid is the key ingredient for the promotion of both IGSCC and TGSCC.

30322 (INIS-XN–200) **The role of nuclear reactor containment in severe accidents.** Nuclear Energy Agency, 75 - Paris (France). Apr 1989. 27p. Order Number DE90626840. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The containment is a structural envelope which completely surrounds the nuclear reactor system and is designed to confine the radioactive releases in case of an accident. This report summarises the work of an NEA Senior Group of Experts who have studied the potential role of containment in accidents exceeding design specifications (so-called severe accidents). Some possibilities for enhancing the ability of plants to reduce the risk of significant off-site consequences by appropriate management of the acident have been examined.

30323 (SA-FOU–89-04) **IGSCC in cold worked austenitic stainless steel in BWR environment.** Persson, B.; Lindblad, B. Swedish Plant Inspectorate, Stockholm (Sweden). Sep 1989. 40p. (In Swedish). Order Number DE90626781. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The survey shows that austenitic stainless steels in a cold worked condition can exhibit IGSCC in BWR environment. It is also found that IGSCC often is initiated as a transgranular crack. Local stresses and surface defects very often acts as starting points for IGSCC. IGSCC due to cold working requires a cold working magnitude of at leas 5%. During cold working a formation of mechanical martensite can take place. The transgranular corrosion occurs in the martensitic phase due to sensitation. The crack propagates integranularly due to anodic solvation of α'-martensite. Sensitation of the martensitic phase is fasten in BCC-structures than in a FCC-structures mainly due to faster diffusion of chromium and carbon which cause precipitation of chromium carbides. Experiments show that a carbon content as low as 0.008% is enough for the formation of 68% martensite and for sensitation. Hydrogen induced cracking is regarded as a mechanism which can accelerate IGSCC. Such cracking requires a hydrostatic stress near the crack tip. Since the oxide in the crack tip is relatively impermeable to hydrogen, cracks in the oxide layer are required for such embrittlement. Hydrogen induced embrittlement of the martensitic phase, at the crack tip, can cause crack propagation. Solution heat treated unstabilized stainless steels are regarded to have a good resistance to IGSCC if they have not undergone cold working. In general, though, Mo-alloyed steels have a better resistance to IGSCC in BWR environment. Regarding the causes for IGSCC, the present literature survey shows that many mechanisms are suggested. To provide a safer ground for the estimation of crack propagation rates, SA recommends SKI to finance a project with the aim to determine the crack propagation rate on proper material. (authors) (65 refs.).

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 30105, 30122, 30318, 30320, 30322, 30344, 30345, 30357, 30359, 30360, 30363, 30366, 30374, 30377, 30379, 30383, 30384, 30385, 30386, 30387, 30388, 30389, 30390, 30391, 30392, 30393, 30394, 30395, 30396, 30397, 30398, 30399, 30400, 30401, 30402, 30403, 30404, 30405, 30406, 30408, 30409, 30410, 30411, 30412, 30413, 30414, 30415, 30417, 30418, 30420, 30421, 30425, 30426, 30428, 30672, 30673, 30674

30324 (CEA-DAS–626) **Technical basis for PWR emergency plans forming.** L'Homme, A.; Manesse, D.; Gauvain, J.; Crabol, B. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1989. 12p. (In French). (CONF-8906137–: Joint NEA/CEC workshop on technical aspects of emergency planning, Brussels (Belgium), 27-29 Jun 1989). Order Number DE90784665. Available from NTIS (US Sales Only), PC A03/MF A01.

Our speech first summarizes the french approach concerning the management of severe accidents which could occur on PWR stations. Then it defines the source-term which is being used as a general support for elaborating the emergency plans devoted to the protection of the population. It describes next the consequences of this source-term on the site and in the environment, which constitute the technical bases for defining actions of utilities and concerned authorities. It gives lastly information on the present status of the different emergency plans and the complementary work undertaken to improve them.

30325 (EUR–12251) **Practices and rules applied for the design of large dry PWR-containments within EC countries.** Karwat, H. (Technische Univ. Muenchen (DE)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. 100p. Contract ECI-1462-B;7221-86D. Available from NTIS (US Sales Only), PC A05/MF A01.

The containment system is an essential component of nuclear power plants and its behaviour plays an important role in the evaluation of accident consequences of pressurized water reactors. The present report illuminates the analytical methods for the simulation of the thermohydraulic loads and the experimental background to support these methods. The national rules and practices applied within the EC member countries to determine the local and global design loads were compared. For thermohydraulic load prediction only small differences have been found, particularly in the required safety addition factors covering the uncertainties of the predictive analytical simulation procedures. Comparison of design loads shows in general that analytical methods are comparable throughout the EC member countries and, with regard to their determination, warrant to a large extent an equal degree of conservatism.

30326 (ORNL/FTR–3581) **[Pressure vessel research user's facility project]: Foreign trip report, March 16–March 30, 1990.** Pennell, W.E.; Pugh, C.E. Oak Ridge National Lab., TN (USA). 25 Apr 1990. 16p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE90010618. Available from NTIS, PC A03/MF A01 - OSTI.

The travelers visited ten European nuclear power regulatory and research organizations for exploratory discussions on the planned Pressure Vessel Research User's Facility (PVRUF) project at ORNL. Objectives for the meetings were to brief the host organizations on the objectives for, and current status of, the PVRUF project and request feedback on: (a) the technical elements of the PVRUF project and (b) the potential for the host organizations' sponsoring the project. The briefings were well received and the host organizations agreed to provide the requested feedback within a three-month period. In a number of instances, additional discussions were held on reactor pressure vessel fracture prevention topics at the request of the host organizations. Information gained in these supplementary discussions is included in this report.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 30366, 30378, 30416, 30420, 30427

30327 (EUR–12059) **Sigma-R: an improved version of the delayed neutron counting device for THTR fuel element verification.** Galantucci, R. (Commission of the European Communities, Luxembourg (LU)); Haas, R.; Janssens, A.; Agostini, P.; Becker, L.; Bernede, M.; Caldon, L.; Cordani, G.; Guardini, S. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 54p. Available from NTIS (US Sales Only), PC A04/MF A01.

SIGMA is a device designed for the Safeguards verification measurements of the ^{235}U content of THTR (or AVR) pebble fuel elements; it has been in operation for more than 12 years at the HOBEG fuel fabrication plant in HANAU (FRG). The THTR fuel element is a 60 mm diameter sphere composed of particles of a U-Th mixture in a graphite matrix. The device is schematically composed of an irradiation facility where the pebble is irradiated by

^{252}Cf and a counting facility where the delayed fission neutrons are monitored. The system has recently been thoroughly updated, the modified instrument being called SIGMA-R. SIGMA-R automatically governs the whole charge-discharge, irradiation and counting sequence, collects the measured counts in the microprocessor memory and performs the relevant calculations, including the statistical evaluation. The instructions are given interactively to the inspector through an IRIS terminal. SIGMA-R provides extensive self diagnosis features. The inspector is also informed explicity of malfunctions during routine operation. The instrument is equipped with a permanent memory which facilitates the inspector's work considerably. SIGMA is complementary to the so-called fuel pebble sampling devices (FPSD) which are designed to take a random sample of 10 pebbles out of 1000 directly from the production line. With SIGMA-R it is now possible to measure the ^{235}U content of THTR pebbles very accurately. The uncertainty essentially is limited to Poisson statistics and allows us to evaluate the ^{235}U content in routine operation, with a random error down to 0.15% and a systematic uncertainty estimated at 0.25%, the latter coming from calibration and normalization procedures.

30328 (EUR–12186) **Adaptation of a robot and tools for dismantling of a gas-cooled reactor.** Lewis, C.J.A. (Strachan and Henshaw, Bristol (UK)); Vibert, C.J.T. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 60p. Contract FI1D-0038. Available from NTIS (US Sales Only), PC A04/MF A01.

This report details the progress on a research programme to develop the techniques and design necessary to facilitate the use of commercially available industrial manipulator systems and cutting tools in nuclear environments, particularly that envisaged whilst decommissioning a gas-cooled reactor. The technology for the type of control and the machines to perform it already exist in the form of industrial-type robots. Development of the techniques for using these machines in a more operator-sensitive environment, together with the requirements of decontamination and radiation tolerance will enable them to be used in place of expensive purpose-built machines at a considerable cost saving. From this work it was possible to highlight the viability and associated costs of modifying a standard manipulator for use in decommissioning operations.

30329 (EUR–12321) **Ventilation and filtration techniques for handling aerosols produced by thermal cutting operations.** Bishop, A. (UKAEA Northern Research Labs. Windscale, Seascale (UK)). Commission of the European Communities, Luxembourg (Luxembourg). 1989. 49p. Contract FI1D-0006. Available from NTIS (US Sales Only), PC A03/MF A01.

Short Communication

30330 (ORNL/FTR–3595) **[HTGR reactor research and development]: Foreign trip report, March 16–25, 1990.** Jones, H. Oak Ridge National Lab., TN (USA). 19 Apr 1990. 51p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90010010. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US-DOE was invited to attend the "First JAERI Symposium on HTGR Technologies" in Tokyo, Japan, to present papers and to chair a session Mr. A. C. Millunzi, Director, Division of HTGRs, accepted for the US-DOE and submitted the following paper titles and authors to the conference organizers: "Present Status and Future Program of HTGR in the USA," Millunzi, A. C. (US-DOE); "Licensing Overview of the MHTGR," Millunzi, A. C. (US-DOE); "Modular High-Temperature Gas-Cooled Reactor Design," Bramblett, G. C. (General Atomics); "Research and Development Associated With Licensing of MHTGR" Jones, H. (ORNL) The papers were accepted, and the three authors attended the symposium as a US-DOE team. The symposium program and pre-prints of the paper abstracts are attached to this report (Appendix B). Additional papers by US authors from the utility industry will also be found in the program. This traveler also visited JAERI research establishments, with specific tours and discussions relating to the Japan Materials Test Reactor (JMTR) and HTTR reactors, the Helium Engineering Demonstration Loop (HENDEL), and the Very-High-Temperature Reactor Criticals (VHTRC) assembly test facility. All are involved in research under the DOE/JAERI HTGR Collaboration Agreement. Also visited was the NFI fuel manufacturing facility, where fuel for the HTTR was being processed at the time of our visit. Samples of this fuel are to be irradiated later in ORNL's High Flux Isotope Reactor (HFIR).

2105 Power Reactors, Breeding

Refer also to citation(s) 30344, 30358, 30366, 30371, 32021

30331 (CONF-900377–4) **Advanced reactor development: The LMR integral fast reactor program at Argonne.** Till, C.E. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Energy and the environment in the 21st century; Cambridge, MA (USA); 26-28 Mar 1990. Order Number DE90010089. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Reactor technology for the 21st Century must develop with characteristics that can now be seen to be important for the future, quite different from the things when the fundamental materials and design choices for present reactors were made in the 1950s. Argonne National Laboratory, since 1984, has been developing the Integral Fast Reactor (IFR). This paper will describe the way in which this new reactor concept came about; the technical, public acceptance, and environmental issues that are addressed by the IFR; the technical progress that has been made; and our expectations for this program in the near term. 3 figs.

30332 (CONF-900418–10) **PYRO: New capability for isotopic mass tracking in pyroprocess simulation.** Liaw, J.R.; Ackerman, J.P. Argonne National Lab., IL (USA). [1990]. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90010070. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A new computational code package called PYRO has been developed to support the IFR fuel recycle demonstration project in the HFEF/S facility at ANL-W. The basic pyrochemical code PYRO1-1 models the atomic mass flows and phase compositions of 48 essential chemical elements involved in the pyroprocess. It has been extended to PYRO1-2 by linking with the ORIGEN code to track more than 1000 isotopic species, their radioactive decays, and related phenomena. This paper first describes the pyroprocess to be modeled and the pyrochemical capability that has been implemented in PYRO1-1, and then gives a full account on the algorithm of extending it to PYRO1-2 for isotopic mass tracking. Results from several scoping and simulation runs will be discussed to illustrate the significance of modeling in-process radioactive decays. 16 refs., 8 figs., 2 tabs.

30333 (CONF-900418–12) **The neutronic and fuel cycle performance of interchangeable 3500 MWth metal and oxide fueled LMRs.** Fujita, E.K.; Wade, D.C. Argonne National Lab., IL (USA). [1990]. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90009711. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This study summarizes the neutronic and fuel cycle analysis performed at Argonne National Laboratory for an oxide and a metal fueled 3500 MWth LMR. These reactor designs formed the basis for a joint US/European study of LMR ATWS events. The oxide and metal core designs were developed to meet reactor performance specifications that are constrained by requirements for core loading interchangeability and for a small burnup reactivity swing. Differences in the computed performance parameters of the oxide and metal cores, arising from basic differences in their neutronic characteristics, are identified and discussed. It is shown that metal and oxide cores designed to the same ground rules exhibit many similar performance characteristics; however, they differ substantially in reactivity coefficients, control strategies, and fuel cycle options. 12 refs., 2 figs., 12 tabs.

30334 (CONF-900418–14) **Physics studies of higher actinide consumption in an LMR.** Hill, R.N.; Wade, D.C.; Fujita, E.K.; Khalil, H.S. Argonne National Lab., IL (USA). [1990]. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors:

operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90009717. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The core physics aspects of the transuranic burning potential of the Integral Fast Reactor (IFR) are assessed. The actinide behavior in fissile self-sufficient IFR closed cycles of 1200 MWt size is characterized, and the transuranic isotopics and risk potential of the working inventory are compared to those from a once-through LWR. The core neutronic performance effects of rare-earth impurities present in the recycled fuel are addressed. Fuel cycle strategies for burning transuranics from an external source are discussed, and specialized actinide burner designs are described. 4 refs., 4 figs., 3 tabs.

30335 (CONF-900613–2) **Run-beyond-clad-breach oxide testing in EBR-2.** Lambert, J.D.B. (Argonne National Lab., IL (USA)); Bottcher, J.H.; Strain, R.V.; Gross, K.C.; Lee, M.J.; Webb, J.P.; Colburn, R.P.; Ukai, S.; Nomura, S.; Odo, T. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on fast reactor core and fuel structural behavior; Inverness (UK); 4-6 Jun 1990. Order Number DE90009701. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Fourteen tests sponsored by the US and Japan were used to study reliability of breached LMR oxide fuel pins during continued operation in EBR-II for a range of conditions and parameters. The fuel-sodium reaction product governed pin behavior. It extended primary breaches by swelling and promoted secondary failures, yet it inhibited loss of fuel and fission products and enhanced release of delayed neutrons used in monitoring breach condition. Fission gas and cesium, the main contaminants from failures, could be adequately controlled. This positive EBR-II experience suggested that limited operation with failed fuel may be feasible in commercial LMR's. 16 refs., 14 figs., 4 tabs.

30336 (CONF-900617–10) **A method for pressure-pulse suppression in fluid-filled piping.** Shin, Y.W. (Argonne National Lab., IL (USA)); Bielick, E.F.; Wiedermann, A.H.; Ockert, C.E. Argonne National Lab., IL (USA). [1990]. 30p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90010116. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A simple, nondestructive method to suppress pressure pulses in fluid-filled piping was proposed and theoretically analyzed earlier. In this paper, the proposed method is verified experimentally. The results of experiments performed for the range of parameters of practical importance indicated that the attenuation of pressure pulses was in accordance with the theoretical predictions. This paper describes the experimental setup and the test models of the proposed pulse suppression devices and discusses the experimental results. In particular, the measured attenuation factors are presented and compared with the theoretical predictions. 8 refs., 17 figs., 2 tabs.

30337 (WHC-SA–0757) **Transient and static mechanical properties of D9 fuel pin cladding and duct material irradiated to high fluence.** Cannon, N.S.; Huang, F.H.; Hamilton, M.L. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 28p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900623–6: 15. symposium on effects of radiation on materials, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90010856. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Simulated transient tests and standard static mechanical property tests were performed on irradiated specimens of D9, a low-swelling, advanced austenitic stainless steel developed for fast reactor operation. Results of the transient tests were compared with existing data on 316 and HT9 stainless steels. The D9 alloys exhibited the same behavior attributed the fuel adjacency effect (which is characterized by reduced strength and ductility as a result of cladding contact with oxide fuel) observed in 316 stainless steel. In the mechanical property tensile and fracture toughness tests, D9 exhibited a slightly lower fracture toughness than either HT9 or 316 stainless steel. Comparison of tensile strengths indicated that irradiated D9 is stronger than HT9, but slightly weaker than 316 stainless steel. The D9 alloy exhibited a lower tensile ductility than either 316 stainless steel or HT9. The D9 transient and mechanical properties data are now available for computer code analysis of D9 as a fast reactor fuel system material. 15 refs., 12 figs.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 30512

30338 (LA–11629-T) **Gas production and behavior in the coolant of the SP-100 Space Nuclear Power System.** McGhee, J.M. Los Alamos National Lab., NM (USA). Aug 1989. 318p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-36. Order Number DE90010674. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The radiologic generation and subsequent behavior of helium gas in the lithium coolant of SP-100 class space nuclear power reactors was investigated analytically in a two part study. Part One of the study consisted of a calculation of coolant radiologic helium gas production rates in a SP-100 class reactor using the discrete ordinates code TWODANT. Cross sections were developed from ENDF/B-V data via the MATXS6s master cross section library. Cross sections were self shielded assuming one homogeneous core region, and doppler broadened to 1300 K using the cross section preparation code TRANSX. Calculations were performed using an S_4/P_1 approximation and 80 neutron energy groups. Part Two of the study consisted of a theoretical investigation into the behavior of helium gas in the primary loop of lithium cooled space reactors. The SP-100 space power system was used as a representative of such a system. Topics investigated included: (1) heterogeneous and homogeneous nucleation; (2) bubble growth/collapse by diffusion, mechanical temperature/pressure effects, and coalescence; and, (3) the effects on bubble distribution of microgravity, magnetic fields, and inertially induced buoyancy. 104 refs., 78 figs., 28 tabs.

30339 (LA–11807) **Gamma-ray and neutron leakage spectra calculated for unshielded reactors.** Terrell, J. Los Alamos National Lab., NM (USA). May 1990. 45p. Sponsored by U.S. DOE Defense Programs; U.S. DOE Nuclear Energy. DOE Contract W-7405-ENG-36. Order Number DE90010199. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The spectra of neutrons and gamma rays escaping from unshielded reactors have been calculated for a number of simplified cases. Such spectra are important in connection with reactors operating in space orbit around the earth, which would normally have little or no heavy shielding. Reactors in space, such as the Soviet RORSAT spacecraft. Knowledge of the characteristics of their leakage spectra may be useful in understanding or minimizing such interference. The Monte Carlo Neutron-Photon (MCNP) code developed at Los Alamos has been used in these calculations. In the cases considered here the critical assembly is assumed to have spherically symmetrical geometry, with a central core of fissionable material surrounded by one or more shells of other material. The outer shells considered include beryllium, beryllium oxide, sodium, potassium, lithium, lithium hydride, and iron. The results obtained, presented as graphs, show that a number of materials that may be used in space reactors should lead to distinctive gamma-ray and neutron leakage spectra. Measurements of such spectra might well be useful in characterizing an unknown reactor type. 16 refs., 33 figs.

2107 Regulation and Licensing

Refer also to citation(s) 30330, 30382, 30428

30340 (EPRI-NP–6810) **ASME code, Section 11: 1987–1989 revisions and updates: Final report.** Mattu, R.K. (Science Applications International Corp., McLean, VA (USA)); Anderson, W.F.; Connor, L.; Lauderdale, J. Electric Power Research Inst., Palo Alto, CA (USA); Science Applications International Corp., McLean, VA (USA). c Apr 1990. 370p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

ASME Section 11, "Rules for In-Service Inspection of Nuclear Power Plant Components," provides rules for examination, testing, and inspection of components and systems in a nuclear power plant. New editions of Section 11 are issued every three years, and Addenda, which include additions and revisions to each Edition of the Code, are published once a year. This report covers ASME Section 11 updates (proposed and approved), related Nuclear Regulatory Commission activities, information on related Operations and Maintenance standards and special issues such as personnel qualification and training for the period from June 1987 through June 1989. Summary information is also provided on utility In-Service Inspection and In-Service Testing program results, relief requests, and current issues like aging, repair and replacement programs, guidance, maintenance programs, BOP inspections, and Operations and Maintenance Committee activities.

30341 (NUREG–0540-Vol.12-No.1) **Title list of documents made publicly available: January 1–31, 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Apr 1990. 332p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A15/MF A01 - GPO; OSTI; INIS.

This document is a monthly publication containing descriptions of information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes (1) docketed material associated with civilian nuclear power plants and other uses of radioactive materials, and (2) nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. The following indexes are included: Personal Author, Corporate Source, Report Number, and Cross Reference to Principal Documents.

30342 (NUREG–0750-Vol.31-No.2) **Nuclear Regulatory Commission issuances.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Feb 1990. 69p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

30343 (NUREG–0936-Vol.9-No.1) **NRC regulatory agenda: Quarterly report, January–March 1990: Volume 9, No. 1.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Apr 1990. 114p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

The Regulatory Agenda is a quarterly compilation of all rules on which the NRC has recently completed action or has proposed, or is considering action and of all petitions for rulemaking that the NRC has received that are pending disposition.

30344 (NUREG–1125-Vol.11) **A compilation of reports of the Advisory Committee on Reactor Safeguards: 1989 annual: Volume 11.** Nuclear Regulatory Commission, Washington, DC (USA). Apr 1990. 157p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

This compilation contains 54 ACRS reports submitted to the Commission or to the Executive Director for Operations during calendar year 1989. It also includes a report to the Congress on the NRC Safety Research Program. All reports have been made available to the public through the NRC Public Document Room and the US Library of Congress. The reports are divided into two groups: Part 1 – ACRS Reports on Project Reviews, and Part 2 – ACRS Reports on Generic Subjects. Part 1 contains ACRS reports alphabetized by project name and within project name by chronological order. Part 2 categorizes the reports by the most appropriate generic subject area and within subject area by chronological order.

30345 (NUREG/CR–2000-Vol.9-No.3) **Licensee Event Report (LER) compilation for month of March 1990: Volume 9, No. 3.** Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data; Oak Ridge National Lab., TN (USA). Apr 1990. 77p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/NSIC–200-Vol.9-No.3). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This monthly report contains Licensee Event Report (LER) operational information that was processed into the LER data file of the Nuclear Safety Information Center (NSIC) during the one month period identified on the cover of the document. The LER's, from which this information is derived, are submitted to the Nuclear Regulatory Commission (NRC) by nuclear power plant licensees in accordance with federal regulations. Procedures for LER reporting for revisions to those events occurring prior to 1984 are described in NRC Regulatory Guide 1.16 and NUREG-0161, Instructions for Preparation of Data Entry Sheets for Licensee Event Reports. For those events occurring on and after January 1, 1984, LERs are being submitted in accordance with the revised rule contained in Title 10 Part 50.73 of the Code of Federal Regulations (10 CFR 50.73 - Licensee Event Report System) which was published in the Federal Register (Vol. 48, No. 144) on July 26, 1983. NUREG-1022, Licensee Event Report System - Description of Systems and Guidelines for Reporting, provides supporting guidance and information on the revised LER rule.

2108 Economics

Refer also to citation(s) 30100, 30105, 30332, 30333, 30334

30346 (CNIC–00315) **Chinese energy in 21st century and the way for developing nuclear energy.** Guo Xingqu (China Inst. of Nuclear Industry Economics, Beijing, BJ (China)). China Nuclear Information Centre, Beijing, BJ (China). Apr 1988. 12p. (In Chinese). (CINIE–001). Order Number DE90627042. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A computer model, which was based on the scenarios about Chinese population and economy development, for China's long-term energy prediction in 21st century is introduced. According to the results, the total commercial energy consumption by the year of 2020 will be 5.86 to 6.36 times greater than in the year of 1987. The fossil fuel still will be main energy resources in the early stage of the next century. Because using fossil fuel has many disadvantages such as polluting environment, greenhouse effect, large volume for transportation and waste of important raw materials for chemistry industries, it could sharply decline after 2020s, as it annual consumption reaches to 2.5 to 2.66 billion tonnes of coal equivalent. The renewable energy will be increasing, but its share would decrease from 27% in the early stage to 18% in the middle of the next century. After the year of 2040, in order to meet energy demands the nuclear energy could become main energy and its share will excess 50%. China has two PWR plants under construction. Since only a small part of uranium is utilized in PWR and the uranium resource is limited, the best way for developing nuclear energy in China is to build Fast Breeder Reactors (FBR). A computer model for various developing nuclear energy patterns is calculated. The results based on these patterns show that China will meet its energy demands if an experimental FBR is built before the end of this century and the metallic fuelled FBRs are gradually developed after the year of 2010.

30347 (CONF-8809221–8) **LEU fuel cycle analyses for the Belgian BR2 Research Reactor.** Deen, J.R.; Snelgrove, J.L. Argonne National Lab., IL (USA). [1988]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International meeting on reduced enrichment for research and test reactors (RERTR); San Diego, CA (USA); 18-24 Sep 1988. Order Number DE90010403. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Equilibrium fuel cycle characteristics were calculated for reference HEU and two proposed LEU fuel cycles using an 11-group diffusion-theory neutron flux solution in hexagonal-Z geometry. The diffusion theory model was benchmarked with a detailed Monte Carlo core model. The two proposed LEU fuel designs increased the ^{235}U loading 20% and the fuel meat volume 51%. The first LEU design used ^{10}B as a burnable absorber. Either proposed LEU fuel element would provide equilibrium fuel cycle characteristics similar to those of the HEU fuel cycle. Irradiation rates of Co

control followers and Ir disks in the center of the core were reduced 6 ± 1% in the LEU equilibrium core compared to reference HEU core. 11 refs., 4 figs., 5 tabs.

30348 (INIS-mf–12578) **Nuclear power planning study for Saudi Arabia.** Kutbi, I.I.; Matin, Abdul. King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Nuclear Engineering. May 1984. 159p. Order Number DE90627049. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The prospects of application of nuclear energy for production of electricity and desalinated water in the Kingdom are evaluated. General economic development of the country and data on reserves, production and consumption of oil and natural gas are reviewed. Electrical power system is described with data on production and consumption. Estimates of future power demand are made using Aoki method. Costs of production of electricity from 600 MW, 900 MW and 1200 MW nuclear and oil-fired power plants are calculated along with the costs of production of desalinated water from dual purpose nuclear and oil-fired plants. The economic analysis indicates that the cost of production of electricity and desalinated water are in general cheaper from the nuclear power plants. Suggests consideration of the use of nuclear energy for production of both electricity and desalinated water from 1415 H. Further detailed studies and prepartory organizational steps in this direction are outlined. 38 Ref.

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 30333, 30368, 31305, 31858

30349 (CONF-9004138–5) **ABRAC: A microcomputer-based Fortran code for multi-cyle burnup.** Olson, A.P. Argonne National Lab., IL (USA). [1990]. 22p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990. Order Number DE90009714. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Pressurized-water reactors have reactor physics and fuel management characteristics which are very amenable to simplified analysis. Given models which account for the dominant features of core and fuel performance, it is possible to rapidly perform relatively accurate scoping studies of many years of reactor operation in just a few hours on a modern (386-class) microcomputer. Models are described for burnup-dependent cross-section generation, for burnup of fuel under irradiation, and for computation of radial power distributions in hexagonal geometry assuming hexagonal fuel assemblies. Comparisons with more elaborate methods are given in order to validate the models, and to quantify the accuracy of the results. 16 refs., 5 figs., 5 tabs.

30350 Directional effects in transitional resonance spectra and group constants. Hill, R.N. (Argonne National Lab., IL (USA). Engineering Div.); Oh, K.O.; Rhodes, J.D. *Nuclear Science and Engineering (USA)*, 103(1): 25-36 (Sep 1989).

Analytical exploratory investigations indicate that transition effects such as streaming cause a considerable spatial variation in the neutron spectra across resonances; streaming leads to opposite effects in the forward and backward directions. The neglect of this coupled spatial/angular variations of the transitory resonance spectra is an approximation that is common to all current group constant generation methodologies. This paper presents a description of the spatial/angular coupling of the neutron flux across isolated resonances. It appears to be necessary to differentiate between forward-and backward-directed neutron flux components or even to consider components in narrower angular cones. The effects are illustrated for an isolated actinide resonance in a simplified fast reactor blanket problem. The resonance spectra of the directional flux components ϕ^+ and ϕ^-, and even more so the 90-deg cone components, are shown to deviate significantly from the infinite medium approximation, and the differences increase with penetration. The charges in ϕ^+ lead to a decreasing scattering group constant that enhances neutron transmission; the changes in ϕ^- lead to an increasing group constant inhibiting backward scattering. Therefore, the changes in the forward-and backward-directed spectra both lead to increased neutron transmission. Conversely, the flux ($\phi = \phi^+ + \phi^-$) is shown to agree closely with the infinite medium approximation both in the analytical formulas and in the numerical solution. The directional effect cancel in the summation. The forward-and backward-directed flux components are used as weighting spectra to illustrate the group constant changes for a single resonance.

2202 Components and Accessories

Refer also to citation(s) 30284, 30340, 30350, 30423, 30424, 30426, 30655, 30657, 30660, 30675

30351 (CEA-DAS–649) **MC GEE Creek downhole records interpretation from an engineering standpoint.** Pecker, A.; Mohammadioun, G. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1989. 6p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90784667. Available from NTIS (US Sales Only), PC A02/MF A01.

The three moderate to strong motions yielded by the McGee Creek downhole experiments were analyzed from an engineering point of view. Recorded motions were digitized and reoriented to account for rotation of instrument packages during installation. Ground surface response spectra computed from the recorded motions are compared to those obtained from a wave propagation analysis through the surface sediments. It is shown that very good agreement is obtained between computed and recorded motions.

30352 (CEA-DAS–650) **A cooperative NRC/CEA research project on earthquake ground motion on soil sites: overview.** Murphy, A.J.; Mohammadioun, B. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1989. 7p. (CONF-890855–: 10. international conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA (USA), 14-18 Aug 1989). Order Number DE90784663. Available from NTIS (US Sales Only), PC A02/MF A01.

This paper provides an overview of a multi-phase experiment being conducted jointly by the U.S. Nuclear Regulatory Commission and the French Commissariat a l'Energie Atomique. The objective of the experiment is to collect a comprehensive set of data on the propagation of earthquake ground motions vertically through a shallow soil column (on the order of several tens of meters). The data will be used to validate several of the available engineering computer codes for modeling earthquake ground motion. The data set will also be used to develop an improved understanding of the earthquake source function and the potential for non-linear effects controlling the propagation through the shallow soil column.

30353 (EPRI-NP–6720-M) **Microstructure etching and carbon analysis techniques: Final report.** Lowenstein, D.B. (Dominion Engineering, Inc., McLean, VA (USA)); Gorman, J.A. Electric Power Research Inst., Palo Alto, CA (USA); Dominion Engineering, Inc., McLean, VA (USA). c Apr 1990. 25p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of this program was to investigate etching methods and carbon content analytical techniques for characterizing alloy 690 tubing material. Results from initial etching investigations were used to direct further study towards those techniques which exhibited the greatest potential for providing quick, accurate, and reliable methods for assessing potential SCC performance by microstructural characterization. Follow-up investigations of selected methods provided additional evidence of the effectiveness and reproducibility of the selected etches when used by a variety of investigators. The carbon content results were used to assess the need for improved analytical methods to enable meeting the tight carbon limits required by current specifications. The program identified the bromine methanol etch, followed by examination using a scanning electron microscope, as the most suitable alloy 690 etch. However, the need for a suitable etch using optical microscopy was also

identified. A glyceregia etch showed an excellent ability to reveal carbide morphology. Promising grain boundary etches for use with optical microscopy were also identified, including a modified nital etch and a hot oxalic acid etch, but further optimization of one or more of these methods is necessary before they can be fully recommended for use with alloy 690. 2 tabs.

30354 (SA-FOU–89-03) **The significance of cladding material on the integrity of nuclear pressure vessels with cracks.** Sattari-Far, Iradj. Swedish Plant Inspectorate, Stockholm (Sweden). May 1989. 86p. Order Number DE90626780. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The significance of the austenitic cladding layer is reviewed in this literature study. The cladding induced stresses are generally not considered when evaluating the severity of flaws in reactor pressure vessels. It has been shown that this emission may be misleading. The necessity to consider the cladding induced stresses is also emphasized in the latest edition of ASME XI. Contrary to what is commonly assumed, the austenitic cladding displays a charpy V transition region with a low ductility. The interface material (HAZ) is the most influenced region by irradiation, and a transition shift of over 100 degree C may be expected. Because of the significant difference in the thermal expansion coefficients of the cladding and the base metal, cladding induced stresses can be set up. Even after PWHT, residual stresses of yield magnitude remain in the cladding and the HAZ at ambient temperature. The cladding induced stresses are temperature dependent and decrease as the temperature increases. The cladding induced stresses have a significant influence on small defects near the inside surface of a pressure vessel. For semielliptical surface cracks, the maximum CTOD-value along the crack front is not found at the deepest point, but in the cladding/base metal interface, having a magnitude three times higher than the value in the deepest point. It implies that this type of crack would propagate along the clad/base material interface. At some point in time, the crack will reach a geometry which may cause such a severe condition at the deepest point that it will start to grow in the depth direction as well. The initiation and growth behaviour of such cracks need to be investigated to be able to assess the significance of cladding on the integrity of nuclear pressure vessels. (author) (50 figs., 33 refs.).

2203 Fuel Elements

Refer also to citation(s) 30349, 30363

30355 (CNIC–00235) **Development of Uranium-Carrying Ball method for calibration of fuel element failure detecting systems.** Liu Yupu (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Bao Wanping; Lu Cungang. China Nuclear Information Centre, Beijing, BJ (China). 1988. 12p. (In Chinese). (IAE–0047). Order Number DE90626796. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Uranium-Carrying Ball method used for the determination of sensitivity, stability of the fuel element failure detecting systems is developed. A special facility for transporting the ball can be carried out by the flow of the cooling water, so that the failure signal can be simulated. Five different types of the Uranium-Carrying Ball have been developed. Type-I to Type-IV may provide failure signal in terms of uranium quantity or exposure area of uranium. Type-V can be used to simulate micro-flaw and examine the detectability of various detective methods for this kind of defect, at the same time it is difficult for the delayed neutron detector to detect micro-flaw. The results of long-time irradiation and washing test show that the working life of the balls is satisfactory. Using the experimentel facility with the balls, detailed study of the capability of various fuel failure detecting systems have been conducted successfully. The operation is easy and safe, the accuracy of this method is higher than that of other methods, the nuclear fuel consumption as well as the radioactive contamination is low. At present, the research on the failure mechanism is being conducted by means of this method.

2204 Control Systems

Refer also to citation(s) 30370, 30381, 30428

30356 (CEGB-RD/B–6237/R89) **The design and validation of advanced operator support systems for a role in plant safety.** Hughes, G. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Jun 1989. 14p. (CONF-890673–: IWGFR specialists meeting on advanced controls for fast reactors, Argonne, IL (USA), 20-22 Jun 1989). Order Number DE90624998. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Advanced operator support systems have the potential of making a significant contribution to plant safety. This note reviews the different support functions required, the specification of performance criteria and possible approaches for system validation. The importance of the different functions that can be provided is related to the stage of the accident sequence. Also, because of the restricted reliability of any single system, subdivision of the systems is suggested in order to make the maximum contribution at a number of sequential stages. In this way it should be possible to make a significant claim for reduced operator error over the full accident progression, from incipient fault to disaster. The use of performance criteria currently associated with the classification of safety-grade trip systems (e.g. detection failure probability) would seem to provide a sound basis for validation. The validation of systems is seen as a significant task which will rely on the use of design and training-simulator data together with specific plant measurements. Expert systems appear to present particular problems for validation. (author).

30357 (CNIC–00229) **Analysis of electric control logic unit for the engineering safety features of a nuclear power plant.** Zhu Zhicheng (Shanghai Nuclear Engineering Research and Development Inst., SH (China)). China Nuclear Information Centre, Beijing, BJ (China). Jul 1988. 16p. (In Chinese). (NERDI–0005). Order Number DE90626801. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The functions and design principles of the electric control logic unit for the engineering safety features of the Qinshan Nuclear Power Plant are analyzed. When the loss of coolant accidents and the loss of electrical power supply happen singly or simultaneously, the unit can send out control signals automatically, quickly and accurately in a predetermined time sequence after receiving the signal of the protection system. Priority is given to the loss of coolant accidents when both the loss of coolant and the loss of electrical power supply take place. The logic design of this unit is reasonable, and the system is simple, reliable and cheap. The reliability of this unit can be evaluated using digraph matrix analysis (DMA). The unit is composed of CMOS elements. The system complies with the principes of 'redundancy' and 'independence' and it can be checked on line automatically or manually. The unit has been tested with respect to outside magnetic field turbances, high temperature, prolonged operation and seismic conditions, and proved to have good performance.

30358 (CONF-891286–1) **Experimental Breeder Reactor II (EBR-II): Instrumentation for core surveillance.** Christensen, L.J. Argonne National Lab., Idaho Falls, ID (USA). [1989]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International Atomic Energy Agency International Working Group on Fast Reactors; Kalpakkam (India); 12-15 Dec 1989. Order Number DE90010474. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

EBR-II has operated for 25 years in support of several major programs. During this time period, several of the original, non-replaceable, flow sensors, RDT sensors and thermocouples have failed in the primary system. This has led to the development of new sensors and the use of calculated values using computer models of the plant. It is important for the next generation of LMR reactors to minimize or eliminate the use of non-replaceable sensors. EBR-II is perhaps the best modeled reactor in the world, thanks to a dedicated T-H analysis program. The success of this program relied on excellent measurements of temperature and flow in subassemblies in the core. The instrumented subassemblies of the XX series provided that measurement capability. From this test series, EBR-II calculations showed that the core could withstand a loss-of-flow without scram accident and a loss-of-heat sink without scram accident from full reactor power without core damage. From

this, reactor designers can now design with confidence, inherently safe reactors. 11 refs., 8 figs.

30359 (EPRI-NP–6758) **Implementation of an advanced digital feedwater control system at the Prairie Island nuclear generating station: Final report.** Paris, R.E. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear and Advanced Technology Div.); Gaydos, K.A.; Hill, J.O.; Whitson, S.G.; Wirkkala, R. Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). Nuclear and Advanced Technology Div.; Northern States Power Co., Welch, MN (USA). Prairie Island Nuclear Station. c May 1990. 81p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI Project RP2126-4 was a cooperative effort between TVA, EPRI, and Westinghouse which resulted in the demonstration of a prototype of a full range, fully automatic feedwater control system, using fault tolerant digital technology, at the TVA Sequoyah simulator site. That prototype system also included advanced signal validation algorithms and an advanced man-machine interface that used CRT-based soft-control technology. The Westinghouse Advanced Digital Feedwater Control System (ADFCS) upgrade, which contains elements that were part of that prototype system, has since been installed at Northern States Power's Prairie Island Unit 2. This upgrade was very successful due to the use of an advanced control system design and the execution of a well coordinated joint effort between the utility and the supplier. The project experience is documented in this report to help utilities evaluate the technical implications of such a project. The design basis of the Prairie Island ADFCS signal validation for input signal failure fault tolerance is outlined first. Features of the industry-proven system control algorithms are then described. Pre-shipment hardware-in-loop and factory acceptance testing of the Prairie Island system are summarized. Post-shipment site testing, including preoperational and plant startup testing, is also summarized. Plant data from the initial system startup is included. The installation of the Prairie Island ADFCS is described, including both the feedwater control instrumentation and the control board interface. Modification of the plant simulator and operator and I&C personnel training are also discussed. 6 refs., 14 figs., 3 tabs.

30360 **Depressurization to mitigate direct containment heating.** Chambers, R. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Hanson, D.J.; Dallman, R.J.; Odar, F. *Nuclear Technology (USA)*, 88(3): 239-250 (Dec 1989). DOE Contract AC07-76ID01570.

This paper reports the capability to depressurize a three-loop pressurized water reactor during a station blackout sequence assessed using the SCDAP/RELAP5 computer code. During the initial calculations, failure of the pressurizer surge line from creep rupture was predicted prior to relocation of molten core material to the lower plenum. The system response from that pressure boundary failure was then simulated until the accumulators emptied. Additional calculations assessed the accident progression in the even that the surge line did not fail. These calculations were intended to bound in-core damage progression prior to relocation of molten material to the lower plenum.

30361 **Calibrating a vacuum ionization gauge for hydrogen using a frit-type plugging meter.** Vaden, D.E. (Argonne National Lab., Idaho Falls, ID (USA)). *Nuclear Technology (USA)*, 88(3): 325-331 (Dec 1989).

The hydrogen meter leak detectors at the Experimental Breeder Reactor II (EBR-II) are periodically checked with a vacuum ionization gauge to see if the leak detectors are calibrated. The gauge, which measures equilibrium pressure, requires an equation to convert the gauge pressure to the hydrogen concentration in sodium. The original equation is derived from Sievert's law with adjustments for gauge sensitivity to hydrogen and thermal transpiration effects. EBR-II experience has shown that the Sievert's law equation has not been reliable in accurately determining the hydrogen concentration in sodium. It is also difficult to determine the hydrogen gauge sensitivity, which can change with time. This paper reports the development of a new equation over a hydrogen range of 0.063 to 0.230 ppm, by using a frit-type plugging meter to determine the hydrogen concentration when an equilibrium pressure measurement is done. With sodium hydride as the predominant impurity, the impurity saturation temperature (plugging temperature) measured with the plugging meter can be used to calculate the hydrogen concentration.

30362 **Thermionic switched self-actuating reactor shutdown system.** Barrus, D.M.; Shires, C.D.; Brummond, W.A. To Dept. of Energy, Washington, DC. USA Patent 4880596/A/. 14 Nov 1989. Filed date 13 Nov 1987. USA Patent Application 7-120,710. Int. Cl. G21C 7/12. 10p.

The patent describes a self-actuating reactor shutdown system incorporating a thermionic switched electromagnetic latch arrangement which is responsive to reactor neutron flux changes and to reactor coolant temperature changes. The system is self- actuating in that the sensing thermionic device acts directly to release (scram) the control rod (absorber) without reference or signal from the main reactor plant protective and control systems. To be responsive to both temperature and neutron flux effects, two detectors are used, one responsive to reactor coolant temperatures, and the other responsive to reactor neutron flux increase. The detectors are incorporated into a thermionic diode connected electrically with an electromagnetic mechanism which under normal reactor operating conditions holds the control rod in its ready position (exterior of the reactor core).

30363 **Neutron economic reactivity control system for light water reactors.** Luce, R.G.; McCoy, D.F.; Merriman, F.C.; Gregurech, S. To Dept. of Energy, Washington, DC. USA Patent 4879086/A/. 7 Nov 1989. Filed date 27 Sep 1988. USA Patent Application 7-250,040. Int. Cl. G21C 1/00. 14p.

This patent describes a neutron reactivity control system for a LWBR incorporating a stationary seed-blanket core arrangement. The core arrangement includes a plurality of contiguous hexagonal shaped regions. Each region has a central and a peripheral blanket area juxapositioned an annual seed area. The blanket areas contain thoria fuel rods while the annular seed area include seed fuel rods and movable thoria shim control rods.

2205 Environmental Aspects

Refer also to citation(s) 30122, 30161, 30162, 30420, 31454, 31463

30364 (PNL–7144) **An initial inverse calibration of the ground-water flow model for the Hanford unconfined aquifer.** Jacobson, E.A. (Nevada Univ., Reno, NV (USA). Desert Research Inst.); Freshly, M.D. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 45p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90008224. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Large volumes of process cooling water are discharged to the ground form U.S. Department of Energy (DOE) nuclear fuel processing operations in the central portion of the Hanford Site in southeastern Washington. Over the years, these large volumes of waste water have recharged the unconfined aquifer at the Site. This artificial recharge has affected ground-water levels and contaminant movement in the unconfined aquifer. Ground-water flow and contaminant transport models have been applied to assess the impacts of site operations on the rate and direction of ground-water flow and contaminant transport in unconfined aquifer at the Hanford Site. The inverse calibration method developed by Neuman and modified by Jacobson was applied to improve calibration of a ground-water flow model of the unconfined aquifer at the Hanford Site. All information about estimates of hydraulic properties of the aquifer, hydraulic heads, boundary conditions, and discharges to and withdrawals form the aquifer is included in the inverse method to obtain an initial calibration of the ground-water flow model. The purpose of this report is to provide a description of the inverse method, its initial application to the unconfined aquifer at Hanford, and to present results of the initial inverse calibration. 28 refs., 19 figs., 1 tab.

30365 (WHC-SP–0046) **Radiological analysis of the covered and lined 1312-N Basin.** Wilcox, A.D. Westinghouse Hanford Co., Richland, WA (USA). Sep 1987. 61p. Sponsored by U.S. DOE

Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90010485. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The N Reactor Accelerated Safety Enhancement Program (ASEP) includes Project H-797 to install an impervious liner in the 1312-N Basin. The design basis accident for this lined basin is the N Reactor Updated Safety Analysis Report (NUSAR) hypothetical accident. This is the Cold Leg Manifold Break with loss of Emergency Core Cooling (ECC) to the fuel. Fission products that enter the confinement from this accident will be diluted with water from the fog-spray system and will be pumped to the lined 1312-N Basin. This report contains the analytic results showing radioactivity disposition. Models analyzed include the original design; the lined basin, with and without a cover; and several variations for the overflow drain. Both radioactivity released to the river by percolation through the soil and radioactivity released to the atmosphere were calculated. The 30-d thyroid dose at the offsite Low Population Zone (LPZ) was calculated, as was the gamma radiation dose to the basin liner. Radioactive iodine is the most important fission product element, with respect to radiological effects. For this reason, the analysis concentrated on the iodine isotopes and particularly on ^{131}I. 5 refs., 23 figs., 5 tabs.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 30100, 30347, 30361, 30373

30366 (CONF-900418–11) **Reconstruction of pin burnup characteristics from nodal calculations in hexagonal geometry.** Yang, W.S.; Finck, P.J.; Khalil, H.S. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90010547. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A reconstruction method has been developed for recovering pin burnup characteristics from fuel cycle calculations performed in hexagonal-z geometry using the nodal diffusion option of the DIF3D/REBUS-3 code system. Intra-modal distributions of group fluxes, nuclide densities, power density, burnup, and fluence are efficiently computed using polynomial shapes constrained to satisfy nodal information. The accuracy of the method has been tested by performing several numerical benchmark calculations and by comparing predicted local burnups to values measured for experimental assemblies in EBR-11. The results indicate that the reconstruction methods are quite accurate, yielding maximum errors in power and nuclide densities that are less than 2% for driver assemblies and typically less than 5% for blanket assemblies. 14 refs., 2 figs., 5 tabs.

30367 (PB–90-169996/XAB) **NIST (National Institute of Standards and Technology) reactor: Summary of activities July 1988 through June 1989. Technical note, July 1988-June 1989.** O'Connor, C. National Inst. of Standards and Technology (IMSE), Gaithersburg, MD (USA). Reactor Radiation Div. Dec 1989. 326p. (NIST/TN–1272). Available from NTIS, PC A15/MF A02.

Also available from Supt. of Docs. See also PB–89-168017.

This report summarizes all those programs which use the NIST reactor. It covers the period for July 1988 through June 1989. The programs range from the use of neutron beams to study the structure and dynamics of materials through nuclear physics and neutron standards to sample irradiations for activation analysis, isotope production, neutron radiography, and nondestructive evaluation.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 30365, 30375, 30376, 31332

30368 (CONF-900418–9) **Resonance computations for cells with fuel annuli.** Hwang, R.N.; Gelbard, E.M. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990. Order Number DE90010096. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two methods have been developed for the computation of resonance integrals in cells containing annular fuel regions. Both are based on rational approximations. One is a generalization of a one-term rational approximation method developed by Segev for a cell with a single fuel annulus. The second modifies the earlier Chen-Gelbard two-term method originally used for double-heterogeneity calculations. Both methods were tested, in cells with two fuel annuli, for various U^{235} and U^{238} resonances. Both gives resonance integrals accurate enough for practical purposes. The two-term fits are substantially more accurate in some NR cases, but are somewhat more difficult to correct for finite resonance widths. 8 refs., 4 tabs.

30369 (HW–3-1406) **Summary of plant results: Weekly reports, January 10, 1945–June 27, 1945.** Acken, M.F.; Bird, G.W. General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation. 10 Jan 1945. 159p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90010739. Available from NTIS, PC A08/MF A01 - OSTI.

Declassified 6 Mar 1990.

This document provides a summary of plant operation from January 10, 1945 thru June 27, 1945.

2209 Reactor Safety

Refer also to citation(s) 30326, 30330, 30335, 30338, 30339, 30343, 30344, 30356, 30358, 30360, 30362, 30366, 30673, 30674, 31357, 31361, 31362, 31425, 31431, 31434, 31435, 31453, 31571, 31578, 31579, 31580

30370 (BNL-NUREG–44385) **The importance of human performance and procedures in limiting severe accident risks.** Higgins, J.C. Brookhaven National Lab., Upton, NY (USA). Jan 1990. 17p. Sponsored by U.S. DOE Energy Research; Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-900391–6: 1990 American Institute of Chemical Engineers (AIChE) spring health and safety symposium, Orlando, FL (USA), 18-22 Mar 1990). Order Number DE90010013. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Due to the defense in depth concept and redundancy in safety systems utilized, complex industrial plants, such as nuclear power plants (NPPs) can be operated safely. This capability has been demonstrated by many years of safe operation by numerous NPPs in the US and abroad. However, the occurrence of severe accidents has also demonstrated that constant vigilance in a number of areas is necessary to ensure continued safe operation. The areas noted as particularly important are Design, Organization and Management, Maintenance, and Operations (Human Performance). 18 refs.

30371 (CONF-891208–31) **A method for pressure-pulse suppression in fluid-filled piping.** Shin, Y.W. (Argonne National Lab., IL (USA)); Bielick, E.F.; Wiedermann, A.H.; Ockert, C.E. Argonne National Lab., IL (USA). [1989]. 30p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (USA); 10-15 Dec 1989. Order Number DE90010408. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A simple, nondestructive method to suppress pressure pulses in fluid-filled piping was proposed and theoretically analyzed earlier. In this paper, the proposed method is verified experimentally. The results of experiments performed for the range of parameters of practical importance indicated that the attenuation of pressure pulses was in accordance with the theoretical predictions. This paper describes the experimental setup and the test models of the proposed pulse suppression devices and discusses the experimental results. In particular, the measured attenuation factors are presented and compared with the theoretical predictions. 8 ref., 17 fig., 2 tab.

30372 (CONF-9004133–2) **Applicability of base-isolation R&D in non-reactor facilities to a nuclear reactor plant.** Seidensticker, R.W.; Chang, Y.W. Argonne National Lab., IL (USA).

[1990]. 3p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From American power conference; Chicago, IL (USA); 23-25 Apr 1990. Order Number DE90010137. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Seismic isolation is gaining increased attention worldwide for use in a wide spectrum of critical facilities, ranging from hospitals and computing centers to nuclear power plants. While the fundamental principles and technology are applicable to all of these facilities, the degree of assurance that the actual behavior of the isolation systems is as specified varies with the nature of the facility involved. Obviously, the level of effort to provide such assurance for a nuclear power plant will be much greater than that required for, say, a critical computer facility. The question, therefore, is to what extent can research and development (R&D) for non-nuclear use be used to provide technological data needed for seismic isolation of a nuclear power plant. This question, of course is not unique to seismic isolation. Virtually every structural component, system, or piece of equipment used in nuclear power plants is also used in non- nuclear facilities. Experience shows that considerable effort is needed to adapt conventional technology into a nuclear power plant. Usually, more thorough analysis is required, material and fabrication quality-control requirements are more stringent as are controls on field installation. In addition, increased emphasis on maintainability and inservice inspection throughout the life of the plant is generally required to gain acceptance in nuclear power plant application. This paper reviews the R&D programs ongoing for seismic isolation in non-nuclear facilities and related experience and makes a preliminary assessment of the extent to which such R&D and experience can be used for nuclear power plant application. Ways are suggested to improve the usefulness of such non-nuclear R&D in providing the high level of confidence required for the use of seismic isolation in a nuclear reactor plant. 2 refs.

30373 (CONF-9004138–4) **TREAT [Transient Reactor Test Facility] reactor control rod scram system simulations and testing.** Solbrig, C.W.; Stevens, W.W. Argonne National Lab., Idaho Falls, ID (USA). [1990]. 22p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990. Order Number DE90010581. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Air cylinders moving heavy components (100 to 300 lbs) at high speeds (above 300 in/sec) present a formidable end-cushion-shock problem. With no speed control, the moving components can reach over 600 in/sec if the air cylinder has a 5 ft stroke. This paper presents an overview of a successful upgrade modification to an existing reactor control rod drive design using a computer model to simulate the modified system performance for system design analysis. This design uses a high speed air cylinder to rapidly insert control rods (278 lb moved 5 ft in less than 300 msec) to scram an air-cooled test reactor. Included is information about the computer models developed to simulate high-speed air cylinder operation and a unique new speed control and end cushion design. A patent application is pending with the US Patent & Trade Mark Office for this system (DOE case number S-68,622). The evolution of the design, from computer simulations thru operational testing in a test stand (simulating in-reactor operating conditions) to installation and use in the reactor, is also described. 6 figs.

30374 (DOE/ID–10245) **Estimation of core-damage frequency to evolutionary ALWR [advanced light water reactor] due to seismic initiating events: Task 4.3.3.** Brooks, R.D. (TENERA, L. P., Knoxville, TN (USA)); Harrison, D.G.; Summitt, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA); TENERA, L. P., Knoxville, TN (USA). Apr 1990. 81p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–89070). Order Number DE90010861. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The Electric Power Research Institute (EPRI) is presently developing a requirements document for the design of advanced light water reactors (ALWRs). One of the basic goals of the EPRI ALWR Requirements Document is that the core-damage frequency for an ALWR shall be less than 1.0E-5. To aid in this effort, the Department of Energy's Advanced Reactor Severe Accident Program (ARSAP) initiated a functional probabilistic risk assessment (PRA) to determine how effectively the evolutionary plant requirements contained in the existing EPRI Requirements Document assure that this safety goal will be met. This report develops an approximation of the core-damage frequency due to seismic events for both evolutionary plant designs (pressurized-water reactor (PWR) and boiling-water reactor(BWR)) as modeled in the corresponding functional PRAs. Component fragility values were taken directly form information which has been submitted for inclusion in Appendix A to Volume 1 of the EPRI Requirements Document. The results show a seismic core-damage frequency of 5.2E-6 for PWRS and 5.0E-6 for BWRs. Combined with the internal initiators from the functional PRAs, the overall core-damage frequencies are 6.0E-6 for the pwr and BWR, both of which satisfy the 1.0E-5 EPRI goal. In addition, site-specific considerations, such as more rigid components and less conservative fragility data and seismic hazard curves, may further reduce these frequencies. The effect of seismic events on structures are not addressed in this generic evaluation and should be addressed separately on a design-specific basis. 7 refs., 6 figs., 3 tabs.

30375 (EGG-EAST–8608) **A comparison of RELAP5 and TRAC LOCA [loss-of-coolant accident] calculations for the K-14.1 charge at SRS [Savannah River Site].** Davis, C.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). Aug 1989. 87p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010923. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Calculations of a loss-of-coolant accident (LOCA) in K-Reactor at the Savannah River Site (SRS) were performed using the RELAP5 computer code. The results of the RELAP5 calculation were then compared with a TRAC calculation previously performed by Savannah River Laboratory. The calculations represented the early (flow instability) portion of a LOCA initiated by a double-ended guillotine break in the plenum inlet piping in K-Reactor. A RELAP5 model of K-Reactor was developed to perform the calculations. The model represented all six external loops and represented the reactor vessel in a three-dimensional manner. The RELAP5 and TRAC results were compared to illustrate and understand differences and similarities between calculations performed with independent computer codes and input models. The variation between the independent calculations provided an indication of the uncertainty in the calculated results with both codes. Results of the comparison were generally favorable as differences between the calculated results for the water plenum and tank bottom pressures were generally less than the values currently assumed in Savannah River's FLOWTRAN uncertainty studies. 23 refs., 24 figs., 2 tabs.

30376 (EGG-EAST–8984) **Savannah River Site reactor hardware design modification study.** Fisher, J.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 61p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010906. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

A study was undertaken to assess the merits of proposed design modifications to the SRS reactors. The evaluation was based on the responses calculated by the RELAP5 systems code to double-ended guillotine break loss-of-coolant-accidents (DEGB LOCAs). The three concepts evaluated were (a) elevated plenum inlet piping with a guard vessel and clamshell enclosures, (b) closure of both rotovalves in the affected loop, and (c) closure of the pump suction valve in the affected loop. Each concept included a fast reactor shutdown (to 65% power in 100 ms) and a 2-s ac pump trip. For the elevated piping design, system recovery was predicted for breaks in the plenum inlet or pump suction piping; response to the pump discharge break location did not show improvement compared to the present system configuration. The rotovalve closure design improved system response to plenum inlet or pump discharge breaks; recovery was not predicted for pump suction breaks. The pump suction valve closure design demonstrated system recovery for all break locations downstream of the valve. A combination of features is recommended to ensure liquid inventory recovery for all break locations. The elevated piping design performance during pump discharge breaks would be improved with

addition of a dc pump trip in the affected loop. Valve closure design performance for a break location in the short section of piping between the reactor concrete shield and the pump suction valve would benefit from the clamshell enclosing that section of piping. 12 refs., 10 figs., 2 tabs.

30377 (EPRI-NP–6480-Vol.10) **MIST [multiloop integral system test] final report: Volume 10, RELAP5/MOD2 MIST analysis comparison.** Klingenfus, J.A. (B and W Nuclear Service Co., Lynchburg, VA (USA). Engineering and Plant Services Div.); Parece, M.V. Electric Power Research Inst., Palo Alto, CA (USA); B and W Nuclear Service Co., Lynchburg, VA (USA). Engineering and Plant Services Div. c Apr 1990. 292p. Sponsored by Electric Power Research Institute. (NUREG/CR–5395). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The multiloop integral system test (MIST) facility is part of a multiphase program started in 1983 to address small-break loss-of-coolant accidents (SBLOCAs) specific to Babcock & Wilcox (B&W) designed plants. MIST is sponsored by the US Nuclear Regulatory Commission, the B&W Owners Group, the Electric Power Research Institute, and B&W. The unique features of the B&W design, specifically the hot leg U-bends and steam generators, prevented the use of existing integral system data or existing integral system facilities to address the thermal-hydraulic SBLOCA questions. MIST and two other supporting facilities were specifically designed and constructed for this program, and an existing facility — the once-through integral system (OTIS) — was also used. Data from MIST and the other facilities will be used to benchmark the adequacy of system codes, such as RELAP5/MOD2 and TRAC-PF1, for predicting abnormal plant transients. The MIST program included funding for seven individual RELAP pre- and post-test predictions. The comparisons against data and final conclusions are the subject of this volume of the MIST Final Report. 15 refs., 227 figs., 18 tabs.

30378 (EUR–12175) **Chernobyl: a year after.** Cazzaniga, R. (Commission of the European Communities, Ispra (IT). Joint Research Centre); Dominici, G.; Malvicini, A.; Sangalli, E. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 141p. (In Italian). Available from NTIS (US Sales Only), PC A07/MF A01.

The radioactivity measurements in the year after the Chernobyl accident, carried out by the Radioprotection Division of the Joint Research Centre of Ispra, are reported. Air at ground level and in grass, milk, wheat, meat, fishes and man have been measured. The evaluation of the 1987 individual dose equivalent due to the exposure of the population living in N.W. Italy is compared with the dose equivalent absorbed in the year following the accident.

30379 (GRS-F–177) **Reports on research programs in the field of reactor safety sponsored by the Federal Ministry for Research and Technology. Reported period: January 1 - June 30, 1989.** Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Nov 1989. 358p. (In German). Order Number DE90784999. Available from NTIS (US Sales Only), PC A16/MF A01.

Each progress report represents a compilation of individual reports about objectives, the work performed, the results, the next steps of the work etc. The individual reports are prepared in a standard form by the contractors themselves as a documentation of their progress in work and published by the FB Forschungsbetreuung (Research Coordination Department) at the GRS, within the framework of general information of progress in reactor safety research. The individual reports are classified according to the research program on the safety of LWR 1977-1980 of the BMFT. Another table of contents uses the same classification system as applied in the nuclear safety index of the CEC (Commission of the European Communities) and the OECD (Organization for Economic Cooperation and Development). The reports are arranged in the sequence of their project numbers. (orig.).

30380 (GRS-F–178) **List of reports in the field of reactor safety research of BMFT, CEA, EPRI, JSTA und USNRC. Reported period: July 1 to September 30, 1989.** Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Nov 1989. 47p. (In German). Order Number DE90784920. Available from NTIS (US Sales Only), PC A03/MF A01.

This list reviews reports from the Federal Republic of Germany, from France, from Japan and from the United States of America concerning single problems in the field of Reactor Safety Research. According to the cooperation of the Bundesminister fuer Forschung und Technologie (BMFT) with the Commissariat a l'Engergie Atomique (CEA), the Japan Science and Technology Agency (JSTA), the Electric Power Research Institute (EPRI) and the United States Nuclear Regulatory Commission, these reports are available in the Gesellschaft fuer Reaktorsicherheit (GRS). The list pursues the following order: Country of origin, problem area concerned, according to the Reactor Safety Research Programme of the BMFT, reporting organization. The list of reports appears quarterly. (orig.).

30381 (NUREG–1394) **Emergency Response Data System (ERDS) implementation.** Jolicoeur, J. Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data. Apr 1990. 50p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The US Nuclear Regulatory Commission has begun implementation of the Emergency Response Data System (ERDS) to upgrade its ability to acquire data from nuclear power plants in the event of an emergency at the plant. ERDS provides a direct real-time transfer of data from licensee plant computers to the NRC Operations Center. The system has been designed to be activated by the licensee during an emergency which has been classified at an ALERT or higher level. The NRC portion of ERDS will receive the data stream, sort and file the data. The users will include the NRC Operations Center, the NRC Regional Office of the affected plant, and if requested the States which are within the ten mile EPZ of the site. The currently installed Emergency Notification System will be used to supplement ERDS data. This report provides the minimum guidance for implementation of ERDS at licensee sites. It is intended to be used for planning implementation under the current voluntary program as well as for providing the minimum standards for implementing the proposed ERDS rule.

30382 (NUREG–1402) **Closeout of NRC Bulletin 88-05: Nonconforming materials supplied by Piping Supplies, Inc., at Folsom, New Jersey, and West Jersey Manufacturing Company at Williamstown, New Jersey.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. May 1990. 77p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report documents the activities that led to the closeout of U.S. Nuclear Regulatory Commission (NRC) Bulletin 88-05, which was issued on May 6, 1988. The bulletin required that licensees submit information on materials supplied by Piping Supplies, Inc. (PSI) and West Jersey Manufacturing Company (WJM), and requested that they (1) ensure that these materials complied with the American Society of Mechanical Engineers, Boiler and Pressure Vessel Code (ASME Code) and design specifications or were suitable for their intended service or (2) replace such materials. Supplements 1 and 2 were issued on June 15 and August 3, 1988, respectively. In Supplement 2, another affiliated supplier, Chews Landing Metal Manufacturers, Incorporated (CLM), was identified. The staff concluded that (1) the analytical procedures used to qualify the nonconforming parts and the analysis results provide and adequate basis for resolving the staff's concerns regarding fitting and flanges; (2) even though the materials supplied by PSI, WJM, and CLM with falsified certified material test reports do not meet the ASME Code, their use is an acceptable alternative in accordance with Section 50.55a(a)(3)(ii) of Title 10 of the Code of Federal Regulations; (3) activities in response to Bulletin 88-05 regarding fittings and flanges can be closed for all operating plants; and (4) licensees should evaluate the use of product forms other fittings and flanges.

30383 (NUREG/CP–0104, pp. 4.3) **Improved eddy-current inspection for steam generator tubing.** Dodd, C.V. (Oak Ridge National Lab., TN (USA)); Pate, J.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting,

Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

A comparison was made of different types of probes and their performance under different steam generator test conditions. The probe types include the differential bobbin probe, the absolute bobbin probe, the pancake probe and the reflection probe. The generator test conditions include tube supports, copper deposits, magnetite deposits, denting, wastage, pitting, cracking and IGA. The study was based mostly on computed values, with the limited number of test specimens available used to verify the computed results. The instrument readings were computed for a complete matrix of the different test conditions, and then the test conditions determined as a function of the readings in a least-squares technique. A comparison was made in the errors in fit and instrument drift for the different probe types. Measurements and computations were also made of the effect of sampling rate on the accuracy of the defect depth measurement for the bobbin probe. For simple defect signals, a relatively coarse sample rate is sufficient to determine the defect depth. The frequency response of the signal produced as the coil is scanned past the defect determines the desired response of the instrument amplifiers. The computations of the change in instrument reading due to the defects have led to an inversion technique in which the defect properties can be computed from the instrument readings. This has been done both experimentally and analytically for each of these probe types. Experimental measurements have been made for the different probes, including the application of the reflection probe to IGA standards. These reflection probe measurements were made on the tube outer surface with a very sharply focused probe to determine material properties, and from the bore with their standard inspection probe to determine how well this condition can be measured in the field.

30384 (NUREG/CP–0104, pp. 5.3) **Evaluation of check valve monitoring methods.** Haynes, H.D. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Check valves are used extensively in nuclear plant safety systems and balance of plant (BOP) systems. Catastrophic failures of swing check valve have occurred in several nuclear plants and have resulted in water hammer, overpressurization of low-pressure systems and damage to flow system components. These failures have largely been attributed to severe degradation of internal parts (i.e. hinge pins, hinge arms, discs, and disc nut pins) resulting from instability (flutter) of check valve discs under normal plant operating conditions. Present surveillance requirements for check valves have been inadequate for timely detection and trends of such degradation. The NRC has had a continuing strong interest in resolving check valve problems. In support of the NRC's Nuclear Plant Aging Research (NPAR) Program, ORNL has been carrying out an aging assessment of check valves. A primary objective of these studies is to identify, evaluate, and recommend methods for detecting check valve degradation and incipient failure. Several developmental or commercially available check valve diagnostic monitoring methods developed by others are being evaluated by ORNL, including those using acoustic emission, ultrasonic, and radiographic techniques. Two other potential monitoring techniques identified by ORNL are also being studied; one based on fluid pressure noise and one based on magnetic flux. The evaluations in each case have focused on identifying capabilities to provide diagnostic information useful in determining check valve aging and service wear effects (degradation) and/or indication of undesirable operating modes (e.g., disc instability). A description of each monitoring method is provided in this paper including examples of test data acquired under controlled laboratory conditions. In some cases, field test data acquired in-situ are also presented.

30385 (NUREG/CP–0104, pp. 7.11) **Generic Issue 113 dynamic qualification and testing of large bore hydraulic snubbers.** Ware, A.G. (Idaho National Engineering Lab., Idaho Falls (USA)); Nitzel, M.E.; Rahl, T.E.; Edson, J.L.; Page, J.D. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The reliability of large bore hydraulic snubbers (LBHSs) is a present safety concern in nuclear power plants LBHSs are used primarily to restrain large components such as steam generators and reactor coolant pumps during seismic events. The US Nuclear Regulatory Commission (USNRC) developed Generic Issue 113 (GI-113), Dynamic Qualification and Testing of Large Bore Hydraulic Snubbers, with the objective of evaluating the reliability of these snubbers in operating commercial nuclear power plants. For the purposes of this research, LBHSs are defined as those hydraulic snubbers with rated load capacities equal to or greater than 50 Kips. Initially there were no test machines capable of testing LBHSs for functionality, so they were exempted from surveillance testing prior to 1980. When LBHSs were later tested, numerous deficiencies, many of which would render the LBHSs inoperable, were found. This paper describes the INEL/USNRC LBHS research program whose objective is to assess the need to improve the reliability of LBHSs and to determine what, if any, requirements should be implemented to achieve necessary improvements. The program has assessed the current state of LBHSs; including types, approximate numbers and locations of LBHSs in plants; operational, maintenance and current in-service inspection and test requirements; and the availability of state-of-the-art testing equipment. An attempt was made to determine the level of environmental and dynamic qualification. Operating experience data, including information contained in the Nuclear Plant Reliability Data System and Licensee Event Reports, were summarized to determine the modes of snubber failure. The above information, along with the recommendations and conclusions generated in the final stages of the program, are currently planned to be published as a NUREG/CR in late 1989.

30386 (NUREG/CP–0104, pp. 1.1-1.2) **Assessment of generic accident management strategies considered for near term implementation.** Lehner, J.R. (Brookhaven National Lab., Upton, NY (USA)); Luckas, W.J.; Vandenkieboom, J.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The US Nuclear Regulatory Commission (NRC) and the industry are both participating in the identification of measures that can prevent the progression of a severe accident or mitigate its consequences. Information important for evaluating these accident management strategies for specific plants is expected to result from the ongoing Individual Plant Evaluation (IPE) program. However, NRC staff have identified a number of generic strategies which may not have to await the results of the IPE program and therefore can be considered for earlier implementation. The NRC requested two of its contractors, Brookhaven National Laboratory (BNL) and Battelle Pacific Northwest Laboratories (PNL) to evaluate these strategies. The twenty one candidate strategies fall under three broad global strategies: (1) conserving and replenishing limited resources, (2) use of systems/components in innovative applications, and (3) defeating interlocks and component protective trips in emergencies. Some strategies apply to BWRs or PWRs only, other apply to both types of plants. This paper describes the evaluation of the strategies performed by Brookhaven National Laboratory. Brookhaven National Laboratory assessed the proposed strategies by first detailing the objective of the strategy and listing the actions involved in the implementation. A description of the plant systems associated with the strategy was given. Next, the applicability of existing rules or plant procedures to a particular strategy was investigated. This was accomplished by a fairly detailed, but by no means exhaustive review of the emergency operating procedures of several plants, as well as utility and NRC reports related to accident management.

30387 (NUREG/CP–0104, pp. 1.11-1.13) **Mitigation of direct containment heating by intentional reactor coolant system depressurization.** Golden, D.W. (Idaho National Engineering Lab., Idaho Falls (USA)); Miller, J.D.; Odar, F. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC07-76ID01570. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

An investigation of intentional depressurization of the reactor coolant system (RCS) as a means to mitigate direct containment heating (DCH) is presented. A DCH event could occur as the result of the dispersal of molten corium into the containment caused by a high pressure core melt ejection. The resulting containment pressure increase might be sufficient to cause containment failure. The probability of occurrence for a DCH event is a function of the driving pressure for the core melt ejection, the quantity of molten core ejected and the composition of the core melt. Although the latter two parameters are important, the RCS pressure is monitored and can be controlled to some extent by the plant operators during a severe accident. Possible strategies to mitigate DCH include (a) prevent core melting, (b) depressurize the RCS, or (c) take no action. Primary and secondary feed-and-bleed strategies are considered as basic options to prevent core damage. For a station blackout, where the ac power is lost, there is no safety injection. For a TMLB transient, the additional failure of the auxiliary feedwater is assumed. For this transient, a primary or secondary feed-and-bleed strategy using existing systems is not possible because of unavailability of the safety injection and auxiliary feedwater. The operators can take action to depressurize the primary system using the pressurizer power-operated relief valves (PORVs), take no action, or find an emergency source of water independent of ac power to perform a feed-and-bleed operation. The last option may require some minor plant system modifications. Analyses for depressurization of the Surry Nuclear Power Plant are being performed using the SCDAP/RELAP5 code for a hypothetical TMLB sequence. Two cases with different times for the initiation of depressurization are considered. 2 refs. 1 fig.

30388 (NUREG/CP–0104, pp. 1.5-1.6) **Framework for accident management.** Hanson, D.J. (Idaho National Engineering Lab., Idaho Falls (USA)); Meyer, O.R.; Ward, L.W.; Blackman, H.S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC07-76ID01570. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Accident management is an essential element of the Nuclear Regulatory Commission (NRC) Integration Plan for the closure of severe accident issues. This element will consolidate the results from other key elements; such as the Individual Plant Examination (IPE), the Containment Performance Improvement, and the Severe Accident Research Programs, in a form that can be used to enhance the safety programs for nuclear power plants. The NRC is currently conducting an Accident Management Program that is intended to aid in defining the scope and attributes of an accident management program for nuclear power plants. The accident management plan will ensure that a plant specific program is developed and implemented to promote the most effective use of available utility resources (people and hardware) to prevent and mitigate severe accidents. Hardware changes or other plant modifications to reduce the frequency of severe accidents are not a central aim of this program. To accomplish the outlined objectives, the NRC has developed an accident management framework that is comprised of five elements: (1) accident management strategies, (2) training, (3) guidance and computational aids, (4) instrumentation, and (5) delineation of decision making responsibilities. A process for the development of an accident management program has been identified using these NRC framework elements.

30389 (NUREG/CP–0104, pp. 1.7-1.8) **Evaluation of strategies for severe accident prevention and mitigation.** Tokarz, R. (Pacific Northwest Lab., Richland, WA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC06-76RL01830. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The NRC is planning to establish regulatory oversight on severe accident management capability in the US nuclear reactor industry. Accident management includes certain preparatory and recovery measures that can be taken by the plant operating and technical personnel to prevent or mitigate the consequences of a severe accident. Following an initiating event, accident management strategies include measures to (1) prevent core damage, (2) arrest the core damage if it begins and retain the core inside the vessel, (3) maintain containment integrity if the vessel is breached, and (4) minimize offsite releases. Objectives of the NRC Severe Accident Management Program are to assure that technically sound strategies are identified and guidance to implement these strategies is provided to utilities. This paper will describe work performed to date by Pacific Northwest Laboratory (PNL) and Battelle Memorial Institute (BMI) relative to severe accident strategy evaluation, as well as work to be performed and expected results. Working with Brookhaven National Laboratory, PNL evaluated a series of NRC suggested accident management strategies. The evaluation of these strategies was divided between PNL and Brookhaven National Laboratory and a similar paper will be presented by Brookhaven regarding their strategy evaluation. This paper will stress the overall safety issues related to the research and emphasize the strategies that are applicable to major safety issues. The relationship of these research activities to other projects is discussed, as well as planning for future changes in the direction of work to be undertaken.

30390 (NUREG/CP–0104, pp. 10.1-10.2) **A method to integrate human factors expertise into the PRA process.** Wells, J.E. (Lawrence Livermore National Lab., CA (USA)); Banks, W.W. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

In response to the recognition of need, the USNRC has initiated research directed toward the integration of human factors and hardware engineering expertise throughout the PRA process. Success in this area is perceived as vital to the overall credibility of future PRAs. That is, no matter how adequate state of knowledge single task and sequence evaluation methods are, if they are not fully exploited by qualified human factors and human reliability specialists, realistic assessments of human and hardware performance separately, and in combination, will not be achieved. Also, in response to the prevailing state of PRA, the USNRC has initiated research directed toward methods for systematically applying PRA results as a technical base to: (1) retrofit/redesign equipment-centered and personnel-centered components of commercial nuclear power plants, (2) prioritize and resolve industry-wide safety issues involving human behavior, (3) establish risk-based performance measures for monitoring the effectiveness of operations, maintainability, test and surveillance programs, and (4) establish criteria for selecting, training and licensing, and subsequently evaluating the performance of plant personnel. This paper presents a method for integrating broad-based human factors expertise into the probabilistic risk assessment (PRA)/human reliability analysis (HRA) process in a standardized manner to achieve results which: (1) provide more realistic estimates of the impact of human performance on nuclear power safety, (2) can be fully audited, (3) provide a firm technical base for equipment-centered and personnel-centered retrofit/redesign of plants enabling them to meet internally and externally imposed safety standards, and (4) yield human and hardware data capable of supporting inquiries into human performance issues which transcend the individual plant.

30391 (NUREG/CP–0104, pp. 10.9-10.10) **Safety system function trend indicator: Theory and test application.** Azarm,

M.A. (Brookhaven National Lab., Upton, NY (USA)); Carbonaro, J.F.; Boccio, J.L.; Vesely, W.E. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The purpose of this paper is to summarize research conducted on the development and validation of quantitative indicators of safety performance. This work, performed under the Risk-Based Performance Indicator (RBPI) Project, FIN A-3295, for the Office of Research (RES), is considered part of NRC's Performance Indicator Program which is being coordinated through the Office for the Analysis and Evaluation of Operational Data (AEOD). The program originally focused on risk-based indicators at high levels of safety indices (e.g., core-damage frequency, functional unavailabilities, and sequence monitoring). The program was then redirected towards a more amenable goal, safety system unavailability indicators, mainly due to the lack of PRA models and plant data. In that regard, BNL published a technical report that introduced the concept of cycle-based indicators and also described various alternatives of monitoring safety system unavailabilities. Further simplification of these indicators was requested by NRC to facilitate their applications to all plants in a timely manner. This resulted in the development of Safety System Function Trend (SSFT) indicators which minimize the need for detailed system model as well as component history. The theoretical bases for these indicators were developed through various simulation studies to determine the ease of detecting a trend and/or unacceptable performance. These indicators, along with several other indicators, were then generated and compared using plant data as a part of a test application. The SSFT indicators, specifically, were constructed for a total of eight plants, consisting of two systems per plant. Emphasis was placed on examining relative changes, as well as the indicator's actual level. Both the trend and actual indicator level were found to be important in identifying plants with potential problems.

30392 (NUREG/CP–0104, pp. 10.11-10.12) **Risk-based configuration control system: Analysis and approaches.** Samanta, P.K. (Brookhaven National Lab., Upton, NY (USA)); Kim, I.S.; Vesely, W.E.; Lofgren, E.V. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

This paper presents an evaluation of the configuration risks associated with the operation of a nuclear power plant and the approaches to control these risks using risk-based configuration control considerations. In that context, the actual and maximum potential configuration risks at a plant are analyzed and the alternative types criteria for a risk-based configuration control systems are described. The risk-based configuration calculations which are studied here focus on the core-melt frequency impacts from given plant configurations. By calculating the core-melt frequency for given configurations, the configurations which cause large core-melt frequency increases can be identified and controlled. The duration time in which the configuration can exist can then be limited or the core-melt frequency level associated with the configuration can be reduced by various actions. Furthermore, maintenances and tests can be scheduled to avoid the configurations which cause large core-melt frequency increases. Present technical specifications do not control many of these configurations which can cause large core-melt frequency increases but instead focus on many risk-unimportant allowed outage times. Hence, risk-based configuration management can be effectively used to reduce core-melt frequency associated risks at a plant and at the same time can provide flexibility in plant operation. The alternative strategies for controlling the core-melt frequency and other risk contributions include: (1) controlling the increased risk level which is associated with the configuration; (2) controlling the individual configuration risk which is associated with a given duration of a configuration; (3) controlling the time period configuration risk from configurations which occur in a time period.

30393 (NUREG/CP–0104, pp. 10.15-10.16) **Extending the evaluation of MAPPS: Results of user participation.** Gertman, D.I. (Idaho National Engineering Lab., Idaho Falls (USA)); Kopstein, F.; Endicott, R.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

An evaluation of the user friendliness and usefulness of the Maintenance Personnel Performance Simulation model (MAPPS) was conducted at three nuclear facilities. The same protocol, comprised of five parts, was administered to each of the participants. During the first part of the evaluation process, power plant personnel were presented with an orientation and training session. Both the orientation and training were evaluated at the end of the data collection effort. Using a procedure selected by the facility as a guide, a task analysis was then performed in order to elicit plant specific knowledge useful in setting up the MAPPs input deck. For the third part of the evaluation, plant personnel participated in manual preparation of the MAPPs input parameters setup deck and in preparation of the actual data file. Next, personnel then participated in limited debugging of logic in the input deck and subsequent running of the MAPPS model. They also helped in defining parameters for a number of sensitivity runs which were successfully conducted. Lastly, simulation output was reviewed and some preliminary interpretation of the results was performed. Constructive criticisms and commentary were elicited through use of face to face interviews and through the application of a standardized survey. Acceptance of the model was positive with users indicating that MAPPS was able to give users a better understanding of common maintenance related tasks. Many reasons given for making the MAPPS simulation available in a personal computer (PC) environment and increasing the diagnostics available to first time users of the system.

30394 (NUREG/CP–0104, pp. 11.1-11.2) **Severe accident zircaloy oxidation/hydrogen generation behavior noted from in-pile test data.** Cronenberg, A.W. (ESA, Idaho Falls, ID (USA)); Gauntt, R.O.; Osetek, D.J.; Panisko, F.E. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The primary source of hydrogen (H_2) during severe LWR accidents is from oxidation of Zircaloy (Zry) cladding by steam. In a PWR like TMI-2, complete Zry reaction would produce $\simeq$ 1,000 kg H_2; a comparable BWR would yield nearly 2,000 kg H_2. Release of such large quantities of H_2 to containment structures with an air atmosphere could produce destructive deflagrations or explosions, with pressures in excess of design values. An understanding of the processes affecting H_2 production are thus of importance to LWR risk assessment. In this paper Zry-oxidation/H_2-generation data from several in-pile severe-fuel damage (SFD) test programs are presented and compared for common findings. The experiments evaluated include the partial-length ($\simeq$ 0.9 m) 32-rod bundle tests performed in the Power Burst Facility (PBF), the full-length high-temperature (FLHT) tests performed in the National Research Universal (NRU) reactor at Chalk River (Canada), and the smaller (0.5 m rod length) BWR DF-4 test conducted in the Annular Core Research Reactor (ACRR). In summary, in-pile test data indicate: (a) a continued high rate of oxidation during and after Zircaloy melting and relocation; (b) only partial flow area blockages; and (c) destruction of the BWR channel box by Zr-Fe eutectic melt interaction which allows for continued steam access and H_2 generation in degraded fuel bundles. Observation from these tests do not indicate inherent limitations on H_2 generation by core degradation, other than that due to steam supply conditions.

30395 (NUREG/CP–0104, pp. 13.3-13.4) **Use of expert judgment in NUREG-1150.** Wheeler, T.A. (Sandia National Labs.,

Albuquerque, NM (USA)); Harper, F.T.; Ortiz, N.R. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC04-76DP00789. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The expert judgment process used in NUREG-1150, Severe Accident Risks: An Assessment for Five US Nuclear Plants, is an advance over those processes developed in previous probabilistic risk assessments. The new process was used to obtain expert judgment on issues expected to be the main contributors to the potential risk of five nuclear plants. The use of expert judgment helped to incorporate both the experience and the research results obtained since the Reactor Safety Study (USNRC, 1975). The new process also enabled NUREG-1150 to include a comprehensive uncertainty analysis, an analysis that had been lacking in the earlier Reactor Safety Study. This process for gathering expert judgment was developed in response to criticisms applied to the previous Reactor Safety Study by the Lewis Committee (Lewis, 1978) and to review comments of the Kouts Committee (1987) on the draft NUREG-1150. The process is based on accepted decision analysis techniques and findings from the numerous studies involving the quantification of judgment. The result, a formal process for eliciting and documenting expert judgment for risk assessment, is one of the major contributions of NUREG-1150.

30396 (NUREG/CP–0104, pp. 13.5-13.6) **External event analysis methods for NUREG-1150.** Bohn, M.P. (Sandia National Labs., Albuquerque, NM (USA)); Lambright, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC04-76DP00789. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The US Nuclear Regulatory Commission is sponsoring probabilistic risk assessments of six operating commercial nuclear power plants as part of a major update of the understanding of risk as provided by the original WASH-1400 risk assessments. In contrast to the WASH-1400 studies, at least two of the NUREG-1150 risk assessments will include an analysis of risks due to earthquakes, fires, floods, etc., which are collectively known as eternal events. This paper summarizes the methods to be used in the external event analysis for NUREG-1150 and the results obtained to date. The two plants for which external events are being considered are Surry and Peach Bottom, a PWR and BWR respectively. The external event analyses (through core damage frequency calculations) were completed in June 1989, with final documentation available in September. In contrast to most past external event analyses, wherein rudimentary systems models were developed reflecting each external event under consideration, the simplified NUREG-1150 analyses are based on the availability of the full internal event PRA systems models (event trees and fault trees) and make use of extensive computer-aided screening to reduce them to sequence cut sets important to each external event. This provides two major advantages in that consistency and scrutability with respect to the internal event analysis is achieved, and the full gamut of random and test/maintenance unavailabilities are automatically included, while only those probabilistically important survive the screening process. Thus, full benefit of the internal event analysis is obtained by performing the internal and external event analyses sequentially.

30397 (NUREG/CP–0104, pp. 13.11-13.12) **Risk sensitivity due to the consequence parameter uncertainties.** Cazzoli, E. (Brookhaven National Lab., Upton, NY (USA)); Tingle, A.; Grimshaw, C.; Park, C.; Lee, M.; Pratt, W.T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

As a part of the NUREG-1150 analysis, consequences were calculated using the MACCS computer code for postulated releases following a severe accident at five selected power plants. Source terms associated with these accidents reflected uncertainties in the physical processes, and were calculated in a parametric form with inputs originated by a limited Latin Hypercube Sampling (LHS) Monte-Carlo technique. Ranges and distributions for the relevant parameters were obtained from expert elicitation. However, source term characteristics for each type of accident had no uncertainty associated and were based on previous analyses or results of computer simulations. During the reanalysis of the PWR plants (Surry and Zion), a Steam Generator Tube Rupture (SGTR) with Secondary Valve stuck open was identified in the Level 1 assessment to be significant to the overall plant risk. An ad-hoc Level 2 analysis of this sequence showed a potential for large releases and provided some information about characteristics of the accident. Warning time, initial time of release, elevation and energy of release were left to engineering judgment, warning time being the most uncertain parameter. A warning interval of five hours was agreed upon by the analysts. A sensitivity study was performed with respect to all the release characteristics of this accident. Distributions were sampled using the LHS technique and 50 sets of consequences were calculated by MACCS on a unique high source term from the NUREG-1150 analysis for the Zion plant. A regression analysis of the results showed a strong dependency of all conditional consequences to the accident warning interval. Overall risk calculations for the Zion plant, however, do not appear to be very sensitive to the uncertainties, due to a relatively low core damage frequency, with the exception, perhaps of the risk of early health effects. 4 refs.

30398 (NUREG/CP–0104, pp. 14.1-14.2) **Performance of containment penetrations under severe accident loadings.** Parks, M.B. (Sandia National Labs., Albuquerque, NM (USA)); Clauss, D.B. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC04-76DP00789. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The objective of the present paper is to provide a complete summary of efforts to date to better understand the behavior of containment penetrations when subjected to severe accident conditions. The research activities discussed herein are a part of the Containment Integrity Programs, which are managed by Sandia National Laboratories for the US Nuclear Regulatory Commission. The overall goal of the Containment Integrity Programs is to develop test validated methods to predict the ultimate pressure capacity, at elevated temperatures, of light water reactor (LWR) containment structures. In order to accomplish this goal, a series of scale model containment tests have been conducted including a 1:8-scale steel model and a 1:6-scale reinforced concrete model. Because of the reduced scale and limited number of tests, the model tests could not include all of the various penetration designs. Thus, several separate test programs have been conducted in which various features of containment penetrations were tested in order to determine their leakage behavior when subjected to severe accident conditions. Past containment penetration research programs have included testing of typical compression seals and gaskets, electrical penetration assemblies (EPAs), and a personnel airlock. Recently, a series of tests were conducted to determine the leakage behavior of inflatable seals when subjected to postulated severe accident combinations of containment pressure and temperature. Also, there is an ongoing research activity to determine the capacity of bellows that are used at some containment penetrations. These three research programs will form the major portion of this paper.

30399 (NUREG/CP–0104, pp. 14.3-14.4) **Sizewell B containment model test.** Horschel, D.S. (Sandia National Labs., Albuquerque, NM (USA)); George, P.T. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information*

meeting. Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The United Kingdom's Central Electricity Generating Board (CEGB) has tested a 1:10th-scale model of the containment building of Sizewell B to determine its ultimate pressure carrying capability. Sizewell B is a pressurized water reactor that is housed in a prestressed-concrete containment. The design pressure used for the containment and the model is 0.345 MPa. The containment structure is based on a Bechtel design - making it very similar to some of the prestressed containments in the US. The containment model was tested to structural failure to demonstrate its pressure reserve and provide data to benchmark computer analyses. A total of 712 sensors were employed to monitor and record the structural behavior of the model during the hydrostatic tests. The data will be used to validate computer codes used for the design and ultimate load analyses of full-scale containment structures. The Nuclear Regulatory Commission (NRC) is participating in this program to further their understanding of containment performance. Previous containment experimentation has been conducted at Sandia National Laboratories for the NRC, and has included the testing of five steel containments and a 1:6-scale reinforced-concrete containment building. Sandia personnel, acting as the NRC's technical agent, have been participating on the peer review group for the Sizewell B model testing program.

30400 (NUREG/CP–0104, pp. 14.5-14.6) **Assessment of effects of structural response on plant risk. Preliminary results for Peach Bottom Atomic Power Station.** Bohn, M.P. (Sandia National Labs., Albuquerque, NM (USA)); Klamerus, E.W.; Johnson, J.J.; Mraz, M.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The US Nuclear Regulatory Commission has been sponsoring tests at Los Alamos National Laboratory on the dynamic response of Seismic Category I reinforced concrete shear wall structures. As test results accumulated, it became clear that there was a significant difference between as-calculated and measured shear wall stiffnesses and frequencies, and that these differences existed both in static and dynamic tests. For very low level tests, measured frequencies were found to range between 50% and 80% of the computed values. During simulated earthquake tests, measured frequencies were found to further decrease as the earthquake level increased. The observed differences between calculated and measured stiffnesses and frequencies represents a potentially important issue relative to the seismic design and safety of nuclear power plants. Thus, this frequency difference issue has potentially important implications with respect to the safety of power plants during seismic events. In order to assess the importance of this frequency difference issue the US Nuclear Regulatory Commission has funded Sandia National Laboratories to re-evaluate several existing seismic PRAs by modeling and incorporating the effects of the frequency reductions. This report presents the results for the initial re-evaluation of the seismic risk at the Peach Bottom Atomic Power Station.

30401 (NUREG/CP–0104, pp. 14.7-14.8) **The high level vibration test program.** Hofmayer, C.H. (Brookhaven National Lab., Upton, NY (USA)); Curreri, J.R.; Park, Y.J.; Kato, W.Y.; Kawakami, S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

As part of cooperative agreements between the US and Japan, tests have been performed on the seismic vibration table at the Tadotsu Engineering Laboratory of Nuclear Power Engineering Test Center (NUPEC) in Japan. The objective of the test program was to use the NUPEC vibration table to drive large diameter nuclear power piping to substantial plastic strain with an earthquake excitation and to compare the results with state-of-the-art analysis of the problem. The test model was subjected to a maximum acceleration well beyond what nuclear power plants are designed to withstand. A modified earthquake excitation was applied and the excitation level was increased carefully to minimize the cumulative fatigue damage due to the intermediate level excitations. Since the piping was pressurized, and the high level earthquake excitation was repeated several times, it was possible to investigate the effects of ratchetting and fatigue as well. Elastic and inelastic seismic response behavior of the test model was measured in a number of test runs with an increasing excitation input level up to the limit of the vibration table. In the maximum input condition, large dynamic plastic strains were obtained in the piping. Crack initiation was detected following the second maximum excitation run. Crack growth was carefully monitored during the next two additional maximum excitation runs. The final test resulted in a maximum crack depth of approximately 94% of the wall thickness. The HLVT (high level vibration test) program has enhanced understanding of the behavior of piping systems under severe earthquake loading. As in other tests to failure of piping components, it has demonstrated significant seismic margin in nuclear power plant piping.

30402 (NUREG/CP–0104, pp. 14.9-14.10) **Relay testing at BNL [Brookhaven National Laboratory].** Bandyopadhyay, K. (Brookhaven National Lab., Upton, NY (USA)); Hofmayer, C. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Brookhaven National Laboratory (BNL) has conducted a seismic test program on relays. The testing has been performed at Wyle Laboratories. The purpose of the test program was to investigate the influence of various parameters (e.g. input frequency, electrical mode, adjustments) on the seismic capacity levels of relays. A total of 46 specimens of 19 popular relay models have been selected for testing. The single frequency test results provide the seismic capacity of each specimen at various frequencies. The results indicate that most relays are strongly influenced by the input frequencies and directions, electrical modes and contact states. The ratio of the capacity level test response spectrum (TRS) and the sine dwell input of a relay model varied from 2.1 to 4.5 in the frequency range of 5-30 Hz. The average value was 2.3 in the frequency range of 5-15 Hz. Test results of the four models of the same relay type did not demonstrate close dynamic similarity of these models. Importantly, for two models, the operating mode controlled the relay capacity levels. The test results depict characteristics of the relays. The correlation between the capacity level multifrequency TRS and the corresponding single frequency input obtained from the test program will be an effective tool to predict the capacity level TRS for earlier vintage relays for which only single frequency test data exist. Further testing is recommended to confirm the effect of successive short duration contact chatters in tripping a device.

30403 (NUREG/CP–0104, pp. 15.5-15.6) **The MELCOR code system.** Kelly, J.E. (Sandia National Labs., Albuquerque, NM (USA)); Hodge, S.; Madni, I. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC04-76DP00789. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

MELCOR is a computer code system that is being developed to calculate fission product source terms and phenomenological behavior associated with severe nuclear reactor accidents. The primary role of MELCOR is to support risk assessment studies. As such, it is designed to treat all relevant phenomenological regimes in an integrated framework in order to provide coupling between competing physical processes. Both in-vessel and ex-vessel phenomena are simulated as are the responses of the various engineered safety systems. Consequently, accident sequences can be simulated from accident initiation through containment failure and release to the environment. The modeling approach in MELCOR can be characterized as engineering-level. This means that models are selected to represent the key phenomena at a level

that is justified based on the available data. MELCOR is the next generation NRC source term analysis code. It has been built upon the work of the Source Term Code Package, STCP, which it supersedes. Certain models in the STCP (e.g., CORCON) have been incorporated into MELCOR. In addition, models from CONTAIN that are appropriate for MELCOR have also been included. As work progresses in other areas, additional models developed in other NRC programs will be incorporated. MELCOR has been completed to the point that detailed documentation, assessment, and application of the code are warranted. These activities provide a cost-effective means of improving the code. Currently, assessment work is being performed at Sandia, Oak Ridge, and Brookhaven. The activities at Oak Ridge and Brookhaven have been directed toward core melt progression modeling, while those at Sandia have mainly been directed toward containment phenomena. The notable exception at Sandia has been the analysis of the TMI-2 accident.

30404 (NUREG/CP–0104, pp. 15.7-15.8) **Studies of core debris interactions with concrete.** Bradley, D.R. (Sandia National Labs., Albuequerque, NM (USA)); Brockman, J.E.; Copus, E.R.; Powers, D.A.; Greene, G.A.; Alexander, C.A.; Eltawila, F. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The interactions of core debris with structural concrete are classic issues of severe reactor accident analysis. The US Nuclear Regulatory Commission (USNRC) has sponsored experimental and analytical investigations of these interactions for several years. The findings from these studies have been augmented by the complementary BETA test program at the Kernforschungszentrum Karlsruhe in West Germany and more recently by an on-going test program conducted by the ACE consortium conducted at Argonne National Laboratory. The USNRC-sponsored studies have led to the development of the CORCON model of core debris interactions with concrete and the VANESA model of aerosol generation and radionuclide release associated with these interactions. Developments of a more prototypic data base, validation of these computer codes and resolution of the remaining issues have been the foci of the USNRC program over the last 2 years. The data base available for development of the CORCON and VANESA computer models in the past has, consisted predominantly of steel melts interacting with various types of concrete. More recent experiments to validate these models, which are used for containment integrity analyses and risk evaluations, have been directed toward using more nearly prototypic simulants for core debris. Currently, it is believed that most of the issues of core debris interactions with concrete have been or are being resolved. A critical issue that remains outstanding is the effect of water will have on these interactions. Interests are now turning toward application of the technology developed for predicting core debris/concrete interactions to issues of specific reactor systems. The most immediate issues are the spreading of core debris in the drywell of the Mark I boiling water reactor and attack by the debris on the containment shell of this reactor.

30405 (NUREG/CP–0104, pp. 15.9-15.10) **Melt Attack and Coolability Experiments (MACE) program elements and the scoping test.** Sehgal, B.R. (Electric Power Research Institute, Palo Alto, CA (USA)); Rahn, F.J.; Spencer, B.W. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The most important issue in the ex-vessel progression of the severe accidents is whether sufficient energy (heat) can be removed from the discharged melt that the threat to containment integrity is avoided. This issue is pertinent for both the initial and the longer term (hours) interactions of the discharged melt with the BWR and PWR containments. For example, if the superheat of the melt discharged in the Mark-I drywell is removed during the initial interaction, the spreading of the melt could be stopped and the melt attack on the liner precluded. Similarly, for high pressure melt ejection (HPME) in a PWR containment cavity, effective heat removal in the initial melt-structure and/or melt-coolant interactions greatly reduces the direct containment heating loads. The initial/short-term coolability of the melt discharged from the vessel depends upon the containment configuration and the placement of water. Since the initial/short-term coolability of the melt in the PWR and BWR containments is so very much initial-condition dependent and plant specific, it is not the subject of the Melt Attack and Coolability Experiments (MACE) program. The MACE program addresses the generic question of the coolability of the discharged melt spread out to a part of the basemat floor under the reactor vessel. This situation results after the initial/short-term interactions of the melt with water and/or structures found in the BWR and PWR containments. The key issue then is whether the melt, if flooded with water, will quench and remain coolable, so that molten corium concrete interaction (MCCI) is avoided and containment integrity maintained.

30406 (NUREG/CP–0104, pp. 4.1-4.2) **NDE reliability and advanced NDE technology validation.** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Deffenbaugh, J.D.; Good, M.S.; Green, E.R.; Heasler, P.G.; Hutton, P.H.; Reid, L.D.; Simonen, F.A.; Spanner, J.C.; Vo, T.V. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC06-76RL01830. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

This paper reports on progress for three programs: (1) evaluation and improvement in nondestructive examination reliability for inservice inspection of light water reactors (LWR) (NDE Reliability Program), (2) field validation acceptance, and training for advanced NDE technology, and (3) evaluation of computer-based NDE techniques and regional support of inspection activities. The NDE Reliability Program objectives are to quantify the reliability of inservice inspection techniques for LWR primary system components through independent research and establish means for obtaining improvements in the reliability of inservice inspections. The areas of significant progress will be described concerning ASME Code activities, re-analysis of the PISC-II data, the equipment interaction matrix study, new inspection criteria, and PISC-III. The objectives of the second program are to develop field procedures for the AE and SAFT-UT techniques, perform field validation testing of these techniques, provide training in the techniques for NRC headquarters and regional staff, and work with the ASME Code for the use of these advanced technologies. The final program's objective is to evaluate the reliability and accuracy of interpretation of results from computer-based ultrasonic inservice inspection systems, and to develop guidelines for NRC staff to monitor and evaluate the effectiveness of inservice inspections conducted on nuclear power reactors. This program started in the last quarter of FY89, and the extent of the program was to prepare a work plan for presentation to and approval from a technical advisory group of NRC staff.

30407 (NUREG/CP–0104, pp. 5.5-5.6) **Results of gate valve flow interruption tests in the RWCU line environment.** DeWall, K.G. (Idaho National Engineering Lab., Idaho Falls (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Recent testing sponsored by the US Nuclear Regulatory Commission (NRC) showed that for at least some valves installed in nuclear applications, the equations used by industry to size the valves do not conservatively calculate the thrust needed to close the valves under design basis loadings. The tests also showed that the results of in situ valve testing at lower loadings cannot be extrapolated to design basis loadings. Of the three BWR process lines covered under GI-87, an unisolated break in the RWCU supply line was selected for the first phase of testing because such a break would have the greatest safety impact. In this initial test program, two representative RWCU isolation valves were subjected to

the hydraulic qualification tests described in ANSI B16.41, the nuclear valves qualification standard, and then to full flow RWCU pipe break flow interruption tests. In all, fourteen flow interruption tests were performed, ten on Valve A and four on Valve B. In the Valve A tests, the parametric study included varying both the degree of inlet water subcooling and the pressure. Break flows were maintained throughout the 30-second valve closure. The four Valve B tests were all performed at a normal BWR 10°F subcooling, and the inlet pressure only was varied. The test loop and valves were instrumented to determine the valve response to flow, including a load cell installed in the valve stems to measure thrust. Test results show that for the valves tested, the variables used by industry for determining valve thrust are not conservative. The results further indicate that internal valve design differences can result in large response differences and that prototypical testing may be necessary to determine actual valve performance.

30408 (NUREG/CP–0104, pp. 6.1-6.2) **Good practices for effective maintenance to manage aging at NPPs.** Scott, W.B. (Pacific Northwest Lab., Richland, WA (USA)); Enderlin, W.I.; Levy, I.S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC06-76RL01830. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The Nuclear Regulatory Commission's Office of Nuclear Regulatory Research is sponsoring this effort to study maintenance as it relates to aging, under the Nuclear Plant Aging Research (NPAR). Maintenance is the primary means of combating and correcting the effects of aging degradation at nuclear power plants. Maintenance effectiveness directly affects the safety of nuclear power plants. Several recent plant events have shown that improper maintenance or a lack of maintenance can be a significant contributory cause of plant incidents (e.g., transients at Rancho Seco and Davis Besse, and the Salem anticipated transient without scram event). In these, and other events, safety related plant equipment functions have been impaired by poor maintenance practices or a lack of maintenance on the specific equipment or in ancillary equipment that affects the ability of the safety related equipment to function. In some cases, the ancillary equipment has been nonsafety-related equipment, or balance-of-plant equipment that has not received adequate maintenance attention. In addition to the potential for causing safety significant plant transients, poor or lacking maintenance may allow the licensing basis of the plant to be eroded without detection. In some cases, time-related aging degradation of equipment that has not been detected, corrected or managed by the maintenance program has been a significant contributory factor. The NPAR program has developed significant information on aging degradation, detection, mitigation, and correction practices for safety-significant structures, systems and components that can be factored into maintenance programs and their effectiveness.

30409 (NUREG/CP–0104, pp. 6.5-6.6) **Loss-of-coolant accident (LOCA) testing of aged cables for nuclear plant life extension.** Jacobus, M.J. (Sandia National Labs., Albuquerque, NM (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC04-76DP00789. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Sandia National Laboratories is currently conducting long-term aging research on representative samples of nuclear power plant Class 1E cables. The objectives of this program are to determine the suitability of these cables for extended life (beyond 40 year design basis) and to assess various cable condition monitoring (CM) techniques for predicting remaining cable life. Twelve different cable products have been aged for long times at relatively mild exposure conditions with various CM techniques employed during the aging process. Three separate test chambers were used for aging groups of cables to nominal equivalent lifetimes of 20, 40, and 60 years. Following the aging process, the cables in each chamber were exposed to a sequential accident profile consisting of 110 Mrad of high dose rate gamma irradiation followed by a simulated design basis loss-of-coolant accident (LOCA) steam exposure. During the LOCA tests, the cables were energized to a nominal voltage of 10 Vdc. Individual cable insulation resistances (IRs) were monitored automatically throughout the LOCA test at varying scan intervals from 10 seconds during the transient portions of the tests to 5 minutes during long steady portions. Measurements on each individual cable were also performed periodically using an IR test apparatus that was used during aging. Based on these measurements, selected plots of IR as a function of time and temperature for various cables will be presented.

30410 (NUREG/CP–0104, pp. 7.13-7.14) **Improving the reliability of service-water systems at nuclear power plants.** Neitzel, D.A. (Pacific Northwest Lab., Richland, WA (USA)); Johnson, K.I.; Daling, P.M.; Chang, T.Y. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Fouling and clogging caused by sedimentation, corrosion, and the buildup of biological organisms is a persistent problem whenever raw water from a river, lake, or ocean is used as a heat exchange medium. The fouling caused by raw water cooling of service-water systems at nuclear power plants is a particular concern because of the potential for affecting safety-related heat exchangers and components, including online and redundant backup units. Open-cycle service-water, as discussed here, provide cooling to reactor support systems required during shutdown and emergency conditions and relate to those heat exchangers and components cooled directly by raw water. To resolve this issue, the NRC initiated a research program at the Pacific Northwest Laboratory (PNL), to study the conditions that allow fouling and to compare alternative surveillance and control programs to minimize service water system fouling. There is no single solution to biological, sediment, and corrosion fouling. An effective surveillance and control program must satisfy certain criteria to address major areas of the service-water system and the major fouling types. Three fouling program alternatives were developed. Value/impact (or cost/benefit) studies were performed on these three alternatives. The alternative chosen to be most cost effective is a baseline fouling program. It consists of two principal elements of a control program, continuous chlorination (for example during bivalve spawning seasons) and periodic flushing and flow testing of redundant and infrequently used cooling loops, to minimize flow blockage that would result from biofouling and sediment/corrosion product buildup. In addition, a surveillance program is recommended to regularly inspect the intake structure for macroscopic biological fouling organisms, sediment, and corrosion.

30411 (NUREG/CP–0104, pp. 7.7-7.8) **Resolution of generic issue 115, Enhancement of the Reliability of Westinghouse Solid State Protection System.** Reny, D.A. (EG and G Idaho, Inc., Idaho Falls (USA)); Mackowiak, D.P.; Basdekas, D.L. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC07-76ID01570. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

This paper presents the regulatory resolution of Generic Issue 115, Enhancement of the Reliability of Westinghouse solid State Protection System. Generic Issue (GI) 115 addresses the reliability impact of the Westinghouse (W) Solid State Protection System (SSPS) reactor trip function on the frequency of Anticipated Transients Without Scram (ATWS) events at W plants. The regulatory resolution of GI 115 involved a technical evaluation, a regulatory evaluation based on the technical findings, the formulation of a decision rationale, and the recommendation for resolution.

30412 (NUREG/CP–0104, pp. 8.11-8.12) **An approach toward estimating the safety significance of normal and abnormal operating procedures in nuclear power plants.** Grant, T.F.

(Battelle Pacific Northwest Labs., Richland, WA (USA)); Harris, M.S. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

The Nuclear Regulatory Commission's TMI Action Plan calls for a long-term plan to upgrade operating procedures in nuclear power plants. The scope of Generic Issue Human Factors 4.4, which stems from this requirement, includes the recommendation of improvements in nuclear power plant normal and abnormal operating procedures (NOPs and AOPs) and the implementation of appropriate regulatory action. This paper will describe the objectives, methodologies, and results of a Battelle-conducted value impact assessment to determine the costs and benefits of having the NRC implement regulatory action that would specify requirements for the preparation of acceptable NOPs and AOPs by the Commission's nuclear power plant licensees. The results of this value impact assessment are expressed in terms of ten cost/benefit attributes that can be affected by the NRC regulatory action. Five of these attributes require the calculation of change in public risk that could be expected to result from the action which, in this case, required determining the safety significance of NOPs and AOPs. In order to estimate this safety significance, a multi-step methodology was created that relies on an existing Probabilistic Risk Assessment (PRA) to provide a quantitative framework for modeling the role of operating procedures. The purpose of this methodology is to determine what impact the improvement of NOPs and AOPs would have on public health and safety.

30413 (NUREG/CP–0104, pp. 9.9-9.10) **NPAR [Nuclear Plant Aging Research] approach to managing aging in nuclear power plants.** Christensen, J.A. (Pacific Northwest Lab., Richland, WA (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC06-76RL01830. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Over the past 5 years, the Nuclear Plant Aging Research program (NPAR) has been devoted to developing technical understanding of the time dependent processes that, through deterioration of components, systems, or structures (C/S/S), can reduce safety margins in nuclear power plants. A major and necessary element of the program involves the application of this basic knowledge in defining functional approaches to managing aging by anticipating and mitigating important deterioration processes. Fundamental understanding and characterization of aging processes are being accomplished through NPAR-sponsored research projects, review and analysis of aging related information, integration of NPAR results with those from industry and other aging studies, and interfacing of all of these with the existing body of codes, standards and regulatory instruments that convey aging-related guidance to NPP licensees. Products of these efforts are applied to structuring and providing aging-related technical recommendations in forms that are useful in: (1) developing and implementing good aging management practices, (2) developing regulatory guidance and requirements for understanding and managing aging during normal plant operations and in support of license renewal, and (3) planning and implementing other regulatory actions and initiatives in which aging-related concerns have a bearing on scope or priority.

30414 (NUREG/CR–4550-Vol.5-Rev.1-Pt.1) **Analysis of core damage frequency: Sequoyah, Unit 1, internal events: Volume 5, Revision 1, Part 1.** Bertucio, R.C. (E.I. Services, Kent, WA (USA)); Brown, S.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 399p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-2084-Vol.5-Rev.1-Pt.1). Available from NTIS, PC A17/MF A01 - GPO; OSTI; INIS.

This document contains the accident sequence analyses of internally initiated events for the Sequoyah, Unit 1 nuclear power plant. This is one of the five plant analyses conducted as part of the NUREG-1150 effort by the Nuclear Regulatory Commission (NRC). NUREG-1150 documents the risk of a selected group of nuclear power plants. The work performed and described here is an extensive reanalysis of that published in February 1987 as NUREG/CR-4550, Volume 5. It addresses comments from numerous reviewers and significant changes to the plant systems and procedures made since the first report. The uncertainty analysis and presentation of results are also much improved. The mean core damage frequency at Sequoyah was calculated to be 5.7E-5 per year, with a 95 percent upper bound of 1.8E-4 and 5 percent lower bound of 1.2E-5 per year. Loss of coolant type accidents were the largest contributors to core damage frequency, accounting for approximately 62 percent of the total. The next most dominant type of accidents were station blackout (loss of all ac power). These sequences account for 26 percent of core damage frequency. No other type of sequence accounts for more than 10 percent of core damage frequency. The numerical results are dominated by failure to initiate high pressure recirculation due to operator error following loss of coolant accidents. Considerable effort was expended on the modeling of very small LOCAs and station blackout sequences, including the development of a reactor coolant pump seal LOCA model through elicitation of expert opinion. This report evaluates core damage frequency from internally initiated events. The consequences of these accidents are evaluated and reported under separate cover.

30415 (NUREG/CR–4550-Vol.5-Rev.1-Pt.2) **Analysis of core damage frequency: Sequoyah, Unit 1, internal events appendices: Volume 5, Revision 1, Part 2.** Bertucio, R.C. (E.I. Services, Kent, WA (USA)); Brown, S.R. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 661p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-2084-Vol.5-Rev.1-Pt.2). Available from NTIS, PC A99/MF A01 - GPO; OSTI; INIS.

This document contains the appendices for the accident sequence analysis of internally initiated events for the Sequoyah, Unit 1 nuclear power plant. This is one of the five plant analyses conducted as part of the NUREG-1150 effort by the Nuclear Regulatory Commission (NRC). NUREG-1150 documents the risk of a selected group of nuclear power plants. The work performed and described here is an extensive reanalysis of that published in February 1987 as NUREG/CR-4450, Volume 5. It addresses comments from numerous reviewers and significant changes to the plant systems and procedures made since the first report. The uncertainty analysis and presentation of results are also much improved. The mean core damage frequency at Sequoyah was calculated to be 5.7E-5 per year, with 95 percent upper bound of 1.8E-4 and 5 percent lower bound of 1.2E-5 per year. Loss of coolant type accidents were the largest contributors to core damage frequency, accounting for approximately 62 percent of the total. The next most dominant type for accidents were station blackout (loss of all AC power). These sequences account for 26 percent of core damage frequency. No other type of sequence accounts for more than 10 percent of core damage frequency. The numerical results are dominated by failure to initiate high pressure recirculation due to operator error following loss of coolant accidents. Considerable effort was expended on the modeling of very small LOCAs and station blackout sequences, including the development of a reactor coolant pump seal LOCA model through elicitation of expert opinion. This report evaluates core damage frequency from internally initiated events. The consequences of these accidents are evaluated and reported under separate cover.

30416 (NUREG/CR–5514) **Modeling and performance of the MHTGR [Modular High-Temperature Gas-Cooled Reactor] reactor cavity cooling system.** Conklin, J.C. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications; Oak Ridge National Lab., TN (USA). Apr 1990. 27p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM–11451). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The Reactor Cavity Cooling System (RCCS) of the Modular High- Temperature Gas-Cooled Reactor (MHTGR) proposed by the

U.S. Department of Energy is designed to remove the nuclear afterheat passively in the event that neither the heat transport system nor the shutdown cooling circulator subsystem is available. A computer dynamic simulation for the physical and mathematical modeling of and RCCS is described here. Two conclusions can be made form computations performed under the assumption of a uniform reactor vessel temperature. First, the heat transferred across the annulus from the reactor vessel and then to ambient conditions is very dependent on the surface emissivities of the reactor vessel and RCCS panels. These emissivities should be periodically checked to ensure the safety function of the RCCS. Second, the heat transfer from the reactor vessel is reduced by a maximum of 10% by the presence of steam at 1 atm in the reactor cavity annulus for an assumed constant in the transmission of radiant energy across the annulus can be expected to result in an increase in the reactor vessel temperature for the MHTGR. Further investigation of participating radiation media, including small particles, in the reactor cavity annulus is warranted. 26 refs., 7 figs., 1 tab.

30417 (NUREG/IA–0018) **RELAP5/MOD2 assessment, OECD-LOFT small break experiment LP-SB-03.** Guntay, S. (Paul Scherrer Inst., Wuerenlingen (Switzerland)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Paul Scherrer Inst., Wuerenlingen (Switzerland). Apr 1990. 88p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

An analysis of the experimental results and post-test calculations using RELAP5/MOD2 carried out for OECD-LOFT small break experiment LP-SB-3 are presented. Experiment LP-SB-3 was conducted on March 5, 1984 in Loss-of-Fluid Test (LOFT) facility located at the Idaho National Engineering Laboratory (INEL). The experiment simulated a small cold leg break, with concurrent loss of high pressure injection system, and cooldown and recovery by feed and bleed of the steam generator secondary side and accumulator injection, respectively. The analysis was under taken as a part of a program at EIR aimed at developing experience in using the latest generation of best estimate Loss of Coolant Accident (LOCA) analysis computer codes, and to improve understanding of Small Break LOCA transients and as well as a part of a program aimed at assessing the RELAP5/MOD2 code. The latest available version (Cycle 33 to 36.1) of the code was used. The particular test selected for the analysis included several phenomena potentially relevant to any PWR plant operation in Switzerland. This report documents a short post-test analysis of the experiment emphasizing the results of additional analysis performed during the course of this task. RELAP5/MOD2 input model and results of the post-test calculation are documented. Included in the report are the results of a sensitivity analysis which show the predicted thermal-hydraulic response to a different input model. 7 refs., 55 figs., 2 tabs.

30418 (NUREG–O797-Suppl.24) **Safety evaluation report related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2 (Docket Nos. 50-445 and 50-446).** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation. Apr 1990. 169p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

Supplement 24 to the Safety Evaluation Report related to the operation of the Comanche Peak Steam Electric Station (CPSES), Units 1 and 2 (NUREG-0797), has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission (NRC). The facility is located in Somervell County, Texas, approximately 40 miles southwest of Fort Worth, Texas. This supplement reports the status of certain issues that had not been resolved when the Safety Evaluation Report and Supplements 1, 2, 3, 4, 6, 12, 21, 22, and 23 to that report were published. This supplement also includes the evaluations for licensing items resolved since Supplement 23 was issued. Supplement 5 has not been issued. Supplements 7, 8, 9, 10, and 11 were limited to the staff evaluation of allegations investigated by the NRC Technical Review Team. Supplement 13 represented the staff's evaluation of the Comanche Peak Response Team (CPRT) Program Plan, which was formulated by the applicant to resolve various construction and design issues raised by sources external to TU Electric. Supplements 14 through 19 presented the staff's evaluation of the CPSES Corrective Action Program: large- and small-bore piping and pipe supports (Supplement 14); cable trays and cable tray hangers (Supplement 15); conduit supports (Supplement 16); mechanical, civil/structural, electrical, instrumentation and controls, and systems portions of the heating, ventilation, and air conditioning (HVAC) system workscopes (Supplement 17); HVAC structural design (Supplement 18); and equipment qualification (Supplement 19). Supplement 20 presented the staff's evaluation of the CPRT implementation of its Program Plan and the issue-specific action plans, as well as the CPRT's investigations to determine the adequacy of various types of programs and hardware at CPSES.

30419 (PB–90-175449/XAB) **Security of nuclear reactors and special nuclear materials. Directive.** Pike, R. Office of the Deputy Under Secretary of Defense for Policy, Washington, DC (USA). 24 Apr 1978. 11p. (DOD-D–5210.63). Available from NTIS, PC A03/MF A01.

The Directive provides the policy, criteria, and standards for the safeguarding of Department of Defense nuclear reactors and special nuclear material.

30420 (TPR-NS–31-No.1) **Nuclear Safety: Technical progress review, January–March 1990: Volume 31, No. 1.** Silver, E.G. (ed.). Oak Ridge National Lab., TN (USA). [1990]. 158p. Sponsored by U.S. DOE Environment Health & Safety. Available from GPO; $8.50.

This review journal covers significant developments in the field of nuclear safety. Its scope includes the analysis and control of hazards associated with nuclear energy, operations involving fissionable materials, and the products of nuclear fission and their effects on the environment. Primary emphasis is on safety in reactor design, construction, and operation; however, the safety aspects of the entire fuel cycle, including fuel fabrication, spent-fuel processing, nuclear waste disposal, handling of radioisotopes, and environmental effects of these operations, are also treated.

30421 Techniques used for the post-irradiation examination of the light water breeder reactor core. Clayton, J.C. (Bettis Atomic Power Lab., West Mifflin, PA (USA)); Bacvinskas, W.S. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 961.

As part of the development of the Shippingport Pressurized Water Reactor, the Bettis Laboratory designed and built a Light Water Breeder Reactor (LWBR) core for operation in the Shippingport Station. The LWBR core contained 12 hexagonal-shaped modules which were arranged in a symmetric array surrounded by 15 reflector assemblies. Each of the hexagonal modules contained a central movable fuel assembly (seed surrounded by a stationary blanket assembly. The movable seed assemblies were used to control reactivity instead of control rods or soluble poisons. This minimized parasitic neutron capture and improved the breeding characteristics of the core. The fuel was ThO_2 and ThO_2-$^{233}UO_2$ pellets which were sealed in 305-cm long Zircaloy-4 tubes. AFter 5 years of power operation in which the core achieved 29,047 effective full power hours, the LWBR core fuel modules were shipped to the expended core facility in Idaho for disassembly and examination. The purpose of the examinations was to assess fuel module and rod performance and to confirm beginning of life design predictions. This paper describes the remote, underwater measuring equipment used to perform examinations on 13 fuel modules and nondestructive examinations of 19 representative fuel rods.

30422 Population dose considerations for decommissioning. Kennedy, W.E. Jr. (Pacific Northwest Lab., Richland, WA (USA)); Napier, B.A. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC06-76RL01830. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Decontamination and decommissioning of the now operating commercial nuclear reactors after their useful lifetime will provide a source of collective dose and, therefore, needs to be considered in any discussion of the overall collective dose from nuclear fuel-cycle operations. Estimates of the collective dose from decommissioning were made from the reports published by the U.S. Nuclear Regulatory Commission (NRC). These reports contain generic ana/lyses of the Technology, Safety and Costs of decommissioning PWR and BWR stations. The three decommissioning alternatives considered by the NRC include DECON (immediate dismantlement), SAFSTOR (Safe Storage) with 30 years of decay, and ENTOMB (entombment). The collective dose estimates are controlled by the exposures to decommissioning workers, although additional population groups may be exposed. Using the data given in the NRC reports, along with current estimates of the number of operational reactors in the United States, rough estimates of the potential collective dose from decommissioning indicate that between 400 and 1,400 man Sv may result, depending upon the decommissioning alternative selected.

30423 Synthetic aperture focusing technique in real-time and tandem operation for thick section steels. Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Hall, T.E.; Reid, L.D.; Mart, G.A. pp. 686 of Proceedings of the 9th international conference on nondestructive evaluation in the nuclear industry. Iida, K.; Doherty, J.E.; Edelmann, X. American Society for Metals, Metals Park, OH (USA) (1988). DOE Contract AC06-76RL01830. (CONF-880471–: 9. international conference on nondestructive evaluation in the nuclear industry, Tokyo (Japan), 25-28 Apr 1988).

The authors report on a program underway at Pacific Northwest Laboratory (PNL) to move the synthetic aperture focusing technique (SAFT) from the laboratory into the field for the purpose of inspecting light-water reactor (LWR) components. The SAFT technology was developed to produce high-resolution and high signal-to-noise ratio images of ultrasonic anomalies in materials. Other researchers have been involved in developing the 2-D or line SAFT technology, but the one thing that has limited the acceptance of 38-D SAFT is the slow processing rates. This paper describes how a special purpose processor can be used to achieve processing rates of 10 A-scans/second or larger. The tandem mode has been successfully used with SAFT but only on thin materials. This paper also describes how to effectively implement the tandem mode for thick section materials.

30424 Round robin study on defect parameters. Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Heasler, P.G. pp. 686 of Proceedings of the 9th international conference on nondestructive evaluation in the nuclear industry. Iida, K.; Doherty, J.E.; Edelmann, X. American Society for Metals, Metals Park, OH (USA) (1988). DOE Contract AC06-76RL01830. (CONF-880471–: 9. international conference on nondestructive evaluation in the nuclear industry, Tokyo (Japan), 25-28 Apr 1988).

The authors discuss round-robin studies conducted on the effectiveness of ultrasonic testing on crack-like defects in primary piping materials of light water reactors. The defects considered were intergranular stress corrosion cracking (IGSCC), thermal fatigue cracking, and machined notches. The data were collected in two different round robins that were conducted in 1982 and 1986. These round robins used some specimens in common that permits the two studies to be related. The analysis looked at the type of defect, the depth of the defect, and the length of the defect in terms of how each of these affected probability of defect detection. It was found that defect type was very important and the relative importance of defect length and depth was contingent on material and defect type. An in-depth analysis was performed to determine the relationship between the detection performance and these parameters. The data was looked at with regard to defect sizing accuracy, technique effectiveness, defect depth, and defect length. The results are discussed.

30425 Pressurized thermal shock experiments with thick vessels. Bryan, R.H. (Oak Ridge National Lab., Oak Ridge, TN (US)); Merkle, J.G.; Nanstad, R.K.; Robinson, G.C. pp. 939 of Fracture mechanics: Nineteenth symposium. Cruse, T.A. ASTM, Philadelphia, PA (USA) (1988). DOE Contract AC05-84OR21400. (CONF-860675–: 19. national symposium on fracture mechanics (ASTM), San Antonio, TX (USA), 30 Jun - 2 jul 1986).

The authors report a 148-mm-thick pressure vessel containing a long axial flaw subjected to a combined loading of internal pressure and thermal shock. The experiment was performed to investigate the effects of loading sequence on initiation of brittle fracture and the behavior of a crack propagating into ductile regions. Two crack initiation and arrest episodes were generated, in addition to several phases of warm prestressing. Warm prestressing was shown to be effective in inhibiting initiation of cleavage fracture. A crack arrest was observed 88 K above the reference nil-ductility transition temperature.

30426 Probabilistic risk assessment based guidance for piping in-service inspection. Vo, T.V. (Pacific Northwest Lab., Richland, WA (US)); Gore, B.F.; Eschbach, E.J.; Simonen, F.A. *Nuclear Technology (USA),* 88(1): 13-20 (Oct 1989).

Some of the goals of the Nondestructive Evaluation Reliability Program are to assess current inspection requirements for all pressure boundary systems and components, to determine whether improvements to the requirements are needed, and, if necessary, to develop recommendations for revising the American Society of Mechanical Engineers Boiler and Pressure Vessel Code and regulatory requirements. Part of the work performed in addressing this goal was the development and demonstration of a method to establish in-service inspection priorities through the use of probabilistic risk assessment (PRA) results. The Oconee-3 PRA and the observed weld failure data of the nuclear plants operating in the United States are used to identify and prioritize the most risk-important systems for inspection. Failure modes and effects analysis methodology is then used to identify and prioritize the most risk important piping sections of the Oconee-3 emergency feedwater system. Based on the results of this study, this method is demonstrated to be a useful tool for identifying systems and piping sections or welds that need to be inspected.

30427 Cleaning up after Chernobyl. Baverstock, K.F. (Medical Research Council, Harwell (UK). Radiobiological Research Unit). *Nature (London) (UK),* 342(6251): 744 (14 Dec 1989).

Letter-to-the-Editor. CESIUM 137/contamination; IODINE 131/children; IODINE 131/milk; IODINE 131/thyroid; REACTOR ACCIDENTS/chernobylsk-4 reactor; REACTOR ACCIDENTS/fallout; ANNUAL LIMIT OF INTAKE; CONTAMINATION; COWS; CHILDREN; MILK; THYROID; FALLOUT; UNITED KINGDOM

30428 Air systems and their impact upon nuclear safety. Ornstein, Dr. H.L. (U.S. Nuclear Regulatory Commission Office for Analysis and Evaluation of Operational Data,Washington,D.C. (US)). *Proceedings of the American Power Conference (USA),* 50: 1094-1107 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

Many U.S. light water reactors (LWRs) rely upon air systems to actuate or control safety-related equipment during normal operation. However, at most LWRs the air systems themselves are not classified as safety systems. Plant safety analyses typically assume that nonsafety-related air systems become inoperable during transients and accidents, and that the air–operated equipment which is served fails in known, predictable modes (e.g., fails open, fails closed). In addition, air-operated equipment which must function during transients or accidents are provided with a backup air (or nitrogen) supply in the form of safety grade accumulators to ensure that the equipment can continue to perform its intended functions. American and foreign nuclear power plant operating experience shows that contrary to the aforementioned licensing assumption, air systems can have a very significant role in nuclear safety. This paper cites dozens of safety significant events that have occurred at U.S. nuclear power plants which were caused or exacerbated by air systems problems; the most well-known event was the Three Mile Island 2 accident.

24 POWER TRANSMISSION AND DISTRIBUTION

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 30446

30429 (EGG-EA–8245-Vol.2) **PCB/transformer techno-economic analysis model: User manual.** Plum, M.M.; Geimer, R.M. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1989. 39p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90010654. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This model is designed to evaluate the economic viability of replacing or retrofilling a PCB transformer with numerous non-PCB transformer options. Replacement options include conventional, amorphous, amorphous-liquid filled, or amorphous-liquid filled-high performance transformers. The retrofill option is the process that removes and disposes the existing PCB dielectric and replaces this with non-PCB dielectric. Depending on the data available, the skills of the user, and the intent of the analysis, there are three model options available to the user. For practical purposes, Level I requires the least amount of input data from the user while Level III requires the greatest quantity of data. This manual is designed for people who have a minimum of experience with Lotus 123 and are familiar with electrical transformers. This manual covers system requirements, how to install the model on your system, how to get started, how to move around in the model, how to make changes in the model data, how to print information, how to save your work, and how to exit from the model.

30430 (EPRI-EL–6756) **Substation control and protection project: Final report.** Cassel, R.L.; Deliyannides, J.S.; Dzieduszko, J.W.; Harvey, J.H.; Hertz, L.H.; Klancher, F.; Mays, L.M.; McGarry, M.J.; Pettis, L.G.; Pistolese, L.F. Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse ABB Power T and D Co., Coral Springs, FL (USA). Relay and Telecommunications Div. c Apr 1990. 527p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report describes the results of EPRI-sponsored Project RP1359-7, dealing with digital protection and control of transmission class substations. Earlier work involved a study of the feasibility of an integrated protection and control system, specification of functional requirements and selection of the optimum architecture for the system. An integrated system including line, bus and transformer protection was designed, built and laboratory tested. It was subsequently installed at the Deans substation of Public Service Electric and Gas (New Jersey). A standalone, digital transmission line system was built and installed at the Branchburg substation of PSE&G, for coordinated line protection with the integrated system. The system is called WESPAC, an acronym for Westinghouse Substation Protection and Control. 52 refs., 174 figs.

30431 (EPRI-EL–6791-Vol.1) **Cost-benefit analysis of power system reliability: Determination of interruption costs: Volume 1, Measurement methods and potential applications in reliability cost-benefit analysis: Final report.** Sanghvi, A.P. Electric Power Research Inst., Palo Alto, CA (USA); RCG/Hagler, Bailly, Inc., Washington, DC (USA). c Apr 1990. 316p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This study examines and characterizes the impacts and costs of service interruptions to customers. Alternative methods to measure interruption costs are reviewed, and the major steps involved in conducting an interruption cost measurement study are described. The applications of interruption cost data in reliability planning are discussed, and the results of a survey of US and Canadian utilities on reliability planning practices are evaluated. The study also documents two case studies, one for the Bonneville Power administration and one for a major utility in the southeast US. For these studies, surveys of households and commercial and industrial firms were conducted using a survey instrument tailored to each segment. The survey data were statistically analyzed to develop estimates of customer interruption costs that are representative of the "customer mix" at typical delivery points in the network. This study also documents the survey methodology, and presents summary statistics that describe the survey respondents' experience with service reliability and power quality. Finally, the results of econometric analyses of the survey data are described. These analyses identify the subset of variables that best explain the variation in interruption costs across different customer types. This is Volume 1 of a two volume set. 13 figs., 18 tabs.

30432 (EPRI-EL–6791-Vol.2) **Cost-benefit analysis of power system reliability: Determination of interruption costs: Volume 2, Measurement of interruption costs for the Bonneville Power Administration: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); RCG/Hagler, Bailly, Inc., Washington, DC (USA). c Apr 1990. 367p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This study examines and characterizes the impacts and costs of service interruptions to customers. Alternative methods to measure interruption cost are reviewed, and the major steps involved in conducting an interruption cost measurement study are described. The applications of interruption cost data in reliability planning are discussed, and the results of a survey of U.S. and Canadian utilities on reliability planning practices are evaluated. The study also documents two case studies, one for Bonneville Power Administration and one for a major utility in the southeast U.S. For these studies, surveys of households and commercial and industrial firms were conducted using a survey instrument tailored to each segment. The survey data were statistically analyzed to develop estimates of customer interruption costs that are representative of the "customer mix" at typical delivery points in the network. This study also documents the survey methodology, and presents summary statistics that describe the survey respondents' experience with service reliability and power quality. Finally, the results of econometric analyses of the survey data are described. These analyses identify the subset of variables that best explain the variation in interruption costs across different customer types. This is Volume Two of a two volume set. 6 refs., 8 figs., 110 tabs.

30433 (ICLES–89/847G-31, pp. 16) **Using capacitive sensors for AC generator monitoring.** Menard, P.; Bourgeois, J.M. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

Highly adaptable instruments are required for monitoring such ac generator parameters as air gap dimensions or the condition of the wedging system. The air gap is a hostile operating environment, and hence development of techniques for dynamic measurement of such parameters has been slow. Research undertaken about seven years ago by the Institute de recherche d'Hydro-Quebec (IREQ), led to development of a capacitive sensor that meets the demanding criteria of the operating environment and offers the precision required for air gap measurement. Given its exceptional qualities, the sensor was adapted for another application; it can now be used to detect vibration of ac generator stator bars right from the onset of the insulation deterioration process. This paper describes operating and measuring principles of the sensor and outlines results obtained with both applications.

30434 (ICLES–89/847G-31, pp. 8) **Developments in rotating machine on-line partial discharge testing.** Stone, G.C. (Ontario Hydro, Toronto, ON (Canada)); Sedding, H.G. Klempner, G. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

The partial discharge analyzer (PDA) test is a particular version of an on-line partial discharge test which is suitable for hydrogenerators only. The main advantage of the PDA test is that electrical interference is eliminated, thus a skilled person is nor required to do the test. Since 1984, Ontario Hydro has occasionally been monitoring the PD (partial discharge) activity on some large reactor coolant pump motors. The PDA test can not be directly applied to turbine generators. Ontario Hydro has been endeavouring to develop an objective PD test for turbine generators. Two methods investigated involved use of were isolated phase bus couplers and stator slot couplers, the later producing the best results. Progress is being made in developing an objective on-line PD test, although much work remains to be done. The PDA test for hydrogenerators has proven to be a reliable test.

30435 (ICLES–89/847G-31, pp. 13) **Life extension of turbine generators at Lakeview TGS [thermal generating station].** Kapler, J. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

Lakeview Generating Station (GS)is located in Mississauga, Ontario, just few miles west of Toronto, on Lake Ontario. In order to meet the projected power demand in Ontario at the turn of the century and beyond, a decision has been made to examine the condition of the power plant and assess the extent of the rehabilitation required. This report is an overview of the extensive Lakeview GS life extension study, which encompassed many disciplines. A wide range of options are possible and could be evaluated using cost/benefit analysis. Equipment assessment work and estimation of the future machine performance and the cost of future unreliability are required.

30436 (ICLES–89/847G-31, pp. 9) **Development of on-line monitoring of turbine generators at Ontario Hydro.** Lloyd, B. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This report describes briefly the effort to develop new diagnostic techniques to improve condition monitoring of turbine generators, as well as a major research program designed to improve the use of existing generator data. Techniques for thermal monitoring currently under development include a thermal scanning system which is mounted between poles on the rotor of a hydraulic generator, and monitors that will allow measurement of temperature of selected points on a turbine generator rotor. Electrical tests and monitors under development include on-line partial discharge monitoring techniques for turbine generators. Generator data interpretation development includes a generator expert monitoring system (GEMS). Work has concentrated on those areas where deficiencies in existing instrumentation was identified. Improvements in assessment capability are also being sought through reduction in the false alarm rate of existing techniques and by better use of conventional sensor data by means of expert systems concepts.

30437 (ICLES–89/847G-31, pp. 9) **Maintenance practice and life extension in power station rotating machines: A utility perspective.** Mitchell, A.S. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This paper outlines aspects of the maintenance of power station rotating plant and the life extension of such plant from the point of view a particular utility, the Eskom Power Station at the southernmost tip of Africa a large utility by world standards. Maintenance practices include regularly scheduled inspections and overhauls of various parts of the machinery as well as some non-destructive testing. The study of life extension in rotating machines is guided by a framework of 12 questions related to machines. The main conclusion appears to be that feasibility and costs should for one or a small number of stations, in terms of the life extension and availability, efficiency and output improvements possible. Such a limited study would form the basis of a more accurate economic study. An emerging view is that carefully phased additional expenditure on maintenance mayube more effective than on intensive program of life extension work. 2 refs.

30438 (ICLES–89/847G-31, pp. 15) **On-line monitoring practices for turbine generators at Ontrario Hydro.** Kapler, J. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This report consists of a discussion of general monitoring practices at Ontario Hydro and a brief description of a number of specific on-line monitoring practices, including monitoring of the temperature of stator windings, stator cores and rotor windings. As well generating condition, core, insulation overheating and partial discharge on-line monitors are mentioned. Off-line rotor winding shorted turn detectors are also discussed. 1 ref.

30439 (ICLES–89/847G-31, pp. 9) **Monitoring: Has it left the schoolyard yet?.** Heard, J.G. Canadian National Committee, International Conference on Large Electric Systems (Canada). 1989. (CONF-8909325–: Electrical machines maintenance and monitoring, Montreal (Canada), 12-14 Sep 1989; CE–02883). In *Electrical machines maintenance and monitoring.* Available from Canadian Electrical Association, Research & Development, Suite #500, One Westmount Square, Montreal, PQ, CAN H3Z 2P9. Prices: PRICES UPON REQUEST.

This paper presents an introduction to the subject of monitoring and draws attention to the Cigre Study Committee which has compiled information in monitoring practices from a wide range of contributors. In 1982, Cigre Study Committee 11 initiated, through its Working Groups, an investigation into the practice of monitoring. The turbine generator, hydrogenerator, and insulation groups collected information by the circulation of questionnaires, followed by the compilation and reporting of the answers. Reports were published in which summarised the international experience form the standpoint of each individual group. A mass of detailed information was produced from which it was possible to draw general conclusions, but, on practice, only the average practice in those countries which provided the answers. Types of monitoring discussed are turbine generators hydrogenerator, insulation and motor monitoring. It is concluded, that while advances are being made in techniques of monitoring, little is being achieved in improving sensors. It is recommended that an analysis of the really essential aspects of monitoring be undertaken.

2403 Power Transmission Lines and Cables

Refer also to citation(s) 30430, 30431, 30432

30440 (OH/RD–89-105-K) **Evaluation of the pole testing and treating program for distribution lines.** Bartlett, S.A. Ontario Hydro Research Div., Toronto, ON (Canada). 22 May 1989. 43p. (MICROLOG–90-00421). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

For many years, Ontario Hydro has maintained a testing and retreating program for its distribution wood pole population. To evaluate the effectiveness of the program, a survey of 1135 poles was conducted. Of these poles, 698 were not retreated, 435 were

retreated and 2 were unknown. No poles required replacement due to groundline decay even though 66% of the poles were at least 30 years old. This is an unlikely result if there truly is a decay problem at the groundline, and throws doubt on the necessity of retreating wood poles. However, the sample was not truly representative of the overall population of poles on the distribution lines and this conclusion should be treated with caution. It is, therefore, recommended that a system of monitoring the pole population be implemented to enable more definitive conclusions to be made in the future about the retreatment program. It is also recommended that the testing program be continued since 27 poles had sufficient internal decay to require replacement. 1 ref., 7 figs., 1 tab.

30441 (OH/RD–89-129-K) **Evaluation of anchor grouting and bearing pad materials for use in transmission line construction at low temperatures: Field evaluation of anchor grouts: Pullout test results.** Ontario Hydro Research Div., Toronto, ON (Canada). 19 Jan 1989. 42p. (MICROLOG–90-01173). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

In 1987, an investigation was undertaken to assess anchor grouting materials, suitable for use at subfreezing temperatures in Ontario, for the construction of transmission lines. Four materials were identified in laboratory studies as having good potential for field applications. These materials were then subjected to full-scale rock anchor pullout tests in order to verify their in-situ performance. Measures were taken to ensure that only the grout performance would be assessed: to prevent failure of the anchor rod and rock, extra-strong rods were installed in holes deeper than the required embedment depth. Primary phenomena of interest were grout-to-rod bond and grout-to-rock bond failures. Results of the tests are presented, along with recommendations on the use of the tested products. The results are already being used in producing a provisional specification for anchor grouting in rock or concrete for transmission line construction. 12 refs., 13 figs., 15 tabs.

30442 (OH/RD–89-139-K) **Transmission line refurbishment study, tower foundation testing and inspection, Halton JCT to 'old' Cooksville TS [Transformer Station] 'B' 115 kV line.** Tsang, R.H.K.; Radhakrishna, H.S. Ontario Hydro Research Div., Toronto, ON (Canada). 2 Jun 1989. 87p. (MICROLOG–90-01178). Available from PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN.

A foundation testing program was carried out for 115-kV towers in the Oakville (Ontario) area as a continuation of a transmission line refurbishment study. The foundation study consisted of a detailed soil investigation of the backfill material native soil at 3 towers. Full scale foundation testing was performed at Tower 15 on 3 grillage footings. It was observed that better than 95% compaction efficiency was achieved for the backfill material at the towers. The grillage footings, tested under uplift and lateral loads, exhibited displacements in excess of 100 mm under the maximum applied uplift load on two of the grillage legs. At 25 mm uplift displacement, the measured grillage resistance corresponded to the predicted reaction loads. The measured ultimate capacity showed a variability of 30% for the grillages tested, and showed an adequate margin in the factor of safety in relation to the design maximum loads. The footing uplift capacities were controlled by the local bearing type of failure in the backfill above the grillage pads as opposed to the lifting of a truncated pyramid of soil mass. 6 refs., 43 figs., 27 tabs.

2405 Environmental Aspects

Refer also to citation(s) 30459

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 30431, 30432

25 ENERGY STORAGE

30443 (AD-A–216765/8/XAB) **2-kW d-c instantaneous uninterruptible power-supply description. Interim report, 1 October 1987-1 October 1989.** Northup, R.L.; Hammond, R.E. Naval Ocean Systems Center, San Diego, CA (USA). Nov 1989. 22p. (NOSC/TD–1677). Available from NTIS, PC A03/MF A01.

A 2-kW uninterruptible power supply was designed, built, and tested to demonstrate the feasibility of using uninterruptible power supplies (UPSs) to sustain critical loads onboard U.S. Navy ships. Performance requirements were met or exceeded. The design approach is modular and is shown to be expandable from its present 2-kW implementation to 10-kW or more. Implementation would be on Navy ships being newly constructed.

2504 Capacitor Banks

30444 **Binary and ternary gas mixtures for use in glow discharge closing switches.** Hunter, S.R.; Christophorou, L.G. To U.S. Dept. of Energy, Washington, D.C. USA Patent 4896076/A/. 23 Jan 1990. Filed date 27 Apr 1988. USA Patent Application 7 186,856–. Int. Cl. H05B 37/02. vp.

This patent describes a capacitive energy storage system. It comprises: a diffuse-discharge switch; a gas mixture in the diffuse-discharge switch comprising a mixture of He, Ne and Ar in combination with a second compound selected from the group consisting of $(CF_3)_2O$, CF_4, BF_3, GeF_4, WF_6, SiF_4, in combination with a compound selected from the group consisting of TMPD, TMBI, TMAE, TMAB, triethylamine, methylaniline, diethylamine, aniline, Co-ocene, Ch-ocene, Ni-ocene and Fe-ocene; and means for selectively activating the gas mixture to an electrical conductive state.

2506 Thermal

30445 (FRNC-TH–3579) **Inter seasonal ground heat storage through vertical bayonet exchanger array: a predimensioning model.** Baudoin, A. Reims Univ., 51 (France). May 1988. 185p. (In French). Order Number DE90784616. Available from NTIS (US Sales Only), PC A09/MF A01.

A mathematical model for the simulation of a large ground heat storage system is presented; the storage system is composed of multiple (in a cylindrical symmetry configuration) bayonet vertical heat exchangers array, buried in the ground. The storage capacity, the heat and mass transfers and the energy efficiency of the system are analyzed as a function of various dimensional and non dimensional parameters.

2509 Batteries

Refer also to citation(s) 30631, 30884

30446 (AFME–82.066.6) **Rational use of electricity - 1982-1985 operation reports.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1987. 440p. (In French). (AFME–85.91.1002.06). Order Number DE90784625. Available from NTIS (US Sales Only), PC A19/MF A01.

This document reviews the annual activity reports of the PIRSEM (a French R and D Agency) concerning the various research domains aiming at enhancing the electricity rational use in industry: electro chemical energy storage, electro chemical generators, microwave-material interaction, plasma reactors, Zinc electrodes, Nickel plastified electrodes. For each project, the finance ment, research teams or societies involved, goals, stages and achievements are presented.

30447 (PB–90-861089/XAB) **Battery electrolytes. May 1983-September 1988 (A Bibliography from the COMPENDEX data base). Report for May 1983-September 1988.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 177p. Available from NTISPC N01/MF N01.

See also PB–90-861097.

This bibliography contains citations concerning the design, construction, and applications of solid, liquid, and gaseous battery electrolytes. Most recent citations focus on solid state battery electrolytes based on lithium or lithium-related chemistry. Some attention is given to the composition of the electrodes associated with solid state batteries. Electrolyte properties and battery performance, maintenance, and safety are also considered. (This updated bibliography contains 350 citations, none of which are new entries to the previous edition.)

30448 (PB–90-861097/XAB) **Battery electrolytes. October 1988-January 1990 (A Bibliography from the COMPENDEX data base). Report for October 1988-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 45p. Available from NTISPC N01/MF N01.

Supersedes PB–88-869946. See also PB–90-861089.

This bibliography contains citations concerning the design, construction, and applications of solid, liquid, and gaseous battery electrolytes. Most recent citations focus on solid state battery electrolytes based on lithium or lithium-related chemistry. Some attention is given to the composition of the electrodes associated with solid state batteries. Electrolyte properties and battery performance, maintenance, and safety are also considered. (This updated bibliography contains 67 citations, all of which are new entries to the previous edition.)

30449 Electroreduction of $SOCl_2$: 1. AlClsub 3-SOClsub 2 system on Pt electrode. . Mosier-Boss, P.A. (Naval Ocean Sytems Center, San Diego, CA (US)); Szpak, S.; Smith, J.J.; Nowak, R.J. *Journal of the Electrochemical Society (USA),* 136: 2455-2462 (Sep 1989).

The mechanism of $SOCl_2$ reduction on Pt electrodes is examined by linear sweep voltammetry and IR reflectance spectroscopy with the interpretation aided by molecular orbital calculations. The present model emphasizes structural aspects of bulk electrolyte as well as the electrode/electrolyte interphase region. Initially this region is enriched by preferential adsorption of $[Cl_2Al(\leftarrow OSCl_2)_{(2)}]^2$ ions occurring through the S atom of the complexed $SOCl_2$ molecule. Further enhancement is noted at low cathodic overpotentials. At higher overpotentials, SO_2 and unidentified species, P_1 and P_2 are observed. The model requires stability of both P_1 and P_2 when in an absorbed state. The acceptance of the first electron is an irreversible process while the acceptance of the second electron is quasi-reversible. The formulation of final reaction products, viz., Cl^-, S, and SO_2 occurs within the reaction layer.

30450 Electrochemical properties of organic disulfide/thiolate redox couples. Liu, M. (Dept. of Materials Science and Mineral Engineering, Univ. of California, and Materials and Chemical Sciences Div., Lawrence Berkely Lab., Berkeley, CA (USA)); Visco, S.J.; DeJonghe, L.C. *Journal of the Electrochemical Society (USA),* 136(9): 2570-2575 (Sep 1989).

The redox behavior, kinetic reversibility, chemical reversibility, and stability, and the specific adsorption or chemisorption at electrode surfaces of a diverse group of organodisulfide cathode materials have been studied by potential-sweep and potential-step methods. The number of electrons involved in the redox reaction and the diffusion coefficients of the organodisulfide species in electrolyte solutions were determined with a rotating disk electrode in conjunction with chronocoulometry/chronoamperometry. Observations indicate that the overall, stoichiometric reaction of those redox couples is $RSSR + \rightleftarrows$ where R represents an organic moiety. These reactions are chemically reversible, yet kinetically hindered, especially at ambient temperatures. The microscopic reversibility of the redox couples promises the possibility of constructing secondary energy conversion systems based on these materials. The slow electrode kinetics, however, indicates that the introduction of electrocatalysts to assist the electrode reaction may be effective in improving battery performance. The negligible adsorption of these materials at platinum electrodes, in addition, implies that the electrode kinetics can be formulated by simple electrodic equations without consideration of surface coverage.

29 ENERGY PLANNING AND POLICY

2901 Energy Analysis and Modeling

Refer also to citation(s) 30097, 30213, 30243, 30475, 30521, 30558, 30559, 30560, 30561, 30562, 30565, 30587

2902 Economics and Sociology

Refer also to citation(s) 30060, 30230, 30461, 30475, 30496, 30502, 30508, 30517, 31414

30451 (AFME–82.066.5) **Socioeconomics of energy - 1982-1985 operation reports.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1987. 145p. (In French). (AFME–85.91.1002.5). Order Number DE90784623. Available from NTIS (US Sales Only), PC A07/MF A01.

This document reviews the annual activity reports of the PIRSEM (a french R and D Agency) concerning the various research domain involved in the socio-economical evaluation of the energy consumption: regional energy plans, previsional analysis of energy demand, physical aspects energy modelization, raw materials supply strategy; for each project, financement, research teams and societies involved, goals, stages and achievements are presented.

30452 (AFME-FR–18) **Energy prices - 1984-1987.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Oct 1987. 37p. (In French). Order Number DE90784629. Available from NTIS (US Sales Only), PC A03/MF A01.

Statistics are given (tables and graphics) concerning the various energy prices in France from 1984 to 1987: imported-oil prices (various grades) and user prices in the industrial sector, service sector and domestic sector for coal, natural gas, domestic fuel oil, propane, electricity and wood.

30453 (DOE/SR/10749–T4) **Close out report for archaeological investigations on the Savannah River Site, South Carolina.** South Carolina Univ., Columbia, SC (USA). Inst. of Archaeology and Anthropology. Dec 1989. 31p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-81SR10749. Order Number DE90009735. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Archaeological Research Program (SRARP), South Carolina Institute of Archaeology and Anthropology, University of South Carolina conducted archaeological investigations under contract AC09-81SR10749 entitled Archaeological Investigations at the Department of Energy's Savannah River Plant from July 1981 through September 1987. The major emphasis was upon the completion of a 40% stratified sample of the Savannah River Site (SRS) in order to identify and preserve archaeological resources. The investigations were conducted to bring the Savannah River Operations Office into compliance with specific laws and regulations pertaining to the identification and preservation of archaeological and historical resources on federally owned and controlled properties. 15 refs., 3 figs., 12 tabs.

30454 (DOE/SR/10749–T5) **Archaeological resource management plan of the Savannah River Archaeological Research Program.** South Carolina Univ., Columbia, SC (USA). Inst. of Archaeology and Anthropology. Dec 1989. 159p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-81SR10749. Order Number DE90009736. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This Archaeological Resource management Plan addresses the future cultural resource management needs of the United States Department of Energy's (DOE) Savannah River Site (SRS). The archaeological information contained herein is based on prehistoric and historic archaeological syntheses prepared by the Savannah River Archaeological Research Program (SRARP) for the SRS. The syntheses also address future research directions that will facilitate better management of the cultural resources. This document is a prelude to a Programmatic Memorandum of Agreement (PMOA) which, in conjunction with this Archaeological Resource

Management Plan, will assure SRS continued compliance with all applicable federal laws and regulations in concert with any DOE plans, policies and directives. 225 refs., 21 figs., 8 tabs.

30455 (DOE/SR/10749–T6) **Technical synthesis of prehistoric archaeological investigations on the Savannah River Site, Aiken and Barnwell Counties, South Carolina.** Sassaman, K.E.; Brooks, M.J.; Hanson, G.T.; Anderson, D.G. South Carolina Univ., Columbia, SC (USA). Inst. of Archaeology and Anthropology. Dec 1989. 341p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-81SR10749. Order Number DE90009737. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

Archaeological investigations on the United States Department of Energy's (DOE) Savannah River Site (SRS) in south Carolina span 16 years and continue today through a cooperative agreement between DOE and the South Carolina Institute of Archaeology and Anthropology (SCIAA), University of South Carolina. The Savannah River Archaeological Research Program (SRARP) of SCIAA has been and continues to be the sole archaeological consultant for DOE-SRS. This report documents technical aspects of all prehistoric archaeological research conducted by the SRARP between 1973 and 1987. Further, this report provides interpretative contexts for archaeological resources as a basis for an archaeological resource plan reported elsewhere (SRARP 1989), and as a comprehensive statement of our current understanding of Native American prehistory and history.

30456 (OME–90-01726) **Ontario Hydro and economic development: A briefing paper.** Ontario Ministry of Energy, Toronto, ON (Canada). Feb 1989. 233p. (MICROLOG–90-01726). Available from PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This project reviewed the policies and programs of Ontario Hydro and evaluated strategies for improving the utility's potential to stimulate economic activities. The report provides an historical description and analysis of Ontario Hydro's past and current role in economic matters with an evaluation and comparison with the activities of other utilities in Canada. The report also provides a detailed account of the specific policies and procedures of Manitoba Hydro in the building of the Limestone Generating Station for future application to Ontario Hydro. After an assessment of recent recommendations of the report by the Premier's Council, some general observations and conclusions were made. These conclude that Ontario Hydro's performance in carrying out is mission for the people of Ontario was good and its reliability record was satisfactory; the principal mandate of Ontario Hydro of providing reliable, safe, and economical electric power to the province must never be forgotten; the reconfirmation of the importance of public power in the province; the utility's operational activities play a significant role in the economic life of the province, especially in the purchase of goods and services; and for certain areas of the province, there are more effective strategies and mechanisms for ensuring, within the long-term business sense of Ontario Hydro's s activities, greater economic impact, including procurement policy and training and employment programs. 45 tabs., 4 figs.

30457 (SCC–90-02313) **Harnessing science and technology for cold regions.** Science Council of Canada, Ottawa, ON (Canada). Committee on Industrial Policies. Dec 1989. 56p. (MICROLOG–90-02313). Available from PC Science Council of Canada, 100 Metcalfe St., Ottawa, ON, CAN K1P 5M1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report summarizes the science and technology developed to cope with economic development in cold regions, an area in which Canada is a world leader. Background information describes the beginning of such development during World War II, continuing with the oil and gas industry's exploration in the Beaufort Sea and the Mackenzie Delta. As well, the environmental knowledge gained is of great importance to all polar nations. The report identifies constraints on Canadian development of technology, including a small, unstable domestic market, difficulties in maintaining knowledge databases and qualified personnel, the scarcity of research infrastructure and facilities in Canada, the absence of national leadership and goals, and problems in securing foreign markets. Recommendations are given on collecting, perserving and disseminating information, the need for government investment in R&D, ensuring product quality, and strengthening research and training in techology.

2903 Environment, Health, and Safety

Refer also to citation(s) 30160, 30370, 30381, 30517, 30605, 31370, 31371, 31372, 31373, 31374, 31375, 31376, 31377, 31378, 31381, 31382, 31386, 31387, 31390, 31391, 31394, 31396, 31398, 31399, 31400, 31403, 31405, 31406, 31407, 31413, 31414, 31415, 31416, 31438, 31439, 31440, 31443, 31474, 31479, 31480, 31481, 31482, 31483, 31484, 31485, 31486, 31487, 31488, 31489, 31490, 31491, 31492, 31493, 31494, 31495, 31496, 31497, 31498, 31499, 31500, 31501, 31502, 31503, 31504, 31505, 31506, 31507, 31508, 31509, 31510, 31511, 31512, 31513, 31514, 31515, 31516, 31517, 31518, 31519, 31520, 31624, 31627

30458 (AOSTRA–90-02283) **The greenhouse effect and the Alberta fossil fuels industry: A discussion paper.** Wiggins, E.J.; Yurko, W.J. Alberta Oil Sands Technology and Research Authority, Edmonton, AB (Canada). 31 Jul 1989. 45p. (MICROLOG–90-02283). Available from PC Alberta Oil Sands Technology and Research Authority, 500 Highfield Pl., 10010-106 St., Edmonton, AB, CAN T5J 3L8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This study represents a preliminary attempt to assess the effects on the Alberta fossil fuels industry of international action is taken to limit emissions of greenhouse gases, and the measures that might be considered to minimize any negative impact on the provincial economy. The study considers the likely effects on the fossil fuel industry if an arbitrary reduction in fuel use were mandated by national or international policy, and the alternative forms of economic activity that might be available to Alberta, as well as possible ways of reducing the net emission of carbon dioxide to the atmosphere by reducing energy production from fossil fuels. In view of the difficulties in implementing a rapid reduction in fossil fuel usage world-wide, it is assumed that an attack on the greenhouse problem would involve a combination of a concerted effort to discourage forest clearing, a ban on virtually all uses of chlorofluorocarbons, and a staged reduction in fossil fuel use. There will likely be strong pressure to phase out the use of coal for electric power generation. Natural gas consumption for fuel use is likely to continue and expand both domestically and for export, as well as being used in steam-methane reforming, nitrogen fertilizer manufacture, in metallurgical processes and for direct use as a fuel. Overall, it seems likely that Alberta will be able to market all the natural gas it can produce, and at increasing prices. 7 figs., 7 tabs.

30459 (CCME–TS/WM-TRE008-E) **Guidelines for the management of wastes containing polychlorinated biphenyls (PCBs).** Canadian Council of Ministers of the Environment, Downsview, ON (Canada). Sep 1989. 97p. (MICROLOG–90-01263). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The primary purpose of this manual is to recommend environmentally sound practices for the management of wastes containing polychlorinated biphenyls (PCBs). Precedures for decommissioning and decontamination, storage, transportation, disposal, labelling and recordkeeping, and emergency preparedness for PCB-contaiminated equipment and containers, as well as for solid and liquid wastes are covered. Regulations governing generation, storage, transportation and disposal of PCB wastes and emergency response planning are generally administered by the provinces for wastes containing PCBs that are managed within the provinces. For inter-provincial shipments of wastes containing PCBs, the appropriate provincial and federal transportation regulations apply. Appendices contain federal and provincial regulations, as well as a

list of PCB waste types and the U.S. EPA requirments for high efficiency boilers. 11 figs., 4 tabs., 23 refs.

30460 (CONF-900121–6) **Technological and policy options for mitigating greenhouse gas emissions from mobile sources.** Saricks, C.L. Argonne National Lab., IL (USA). [1990]. 33p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From Transportation Research Board meeting; Washington, DC (USA); Jan 1990. Order Number DE90010151. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents issues and explores options for reducing emissions of carbonaceous pollutants from mobile sources. It discusses first what can be expected from current and proposed emission control system designed chiefly to reduce the output of regulated pollutants, then explores opportunities for incremental control of emissions of carbon (bound in gaseous form) that appear at this time to have good potential for success. The presentation of current and anticipated control technologies is organized by vehicle type, considering, in turn, passenger vehicles and light-duty trucks, medium- and heavy-duty vehicles, and non-highway vehicular modes. The discussion of incremental control opportunities focuses first on hardware and (existing) fuels modification for reduced emissions and improved fuel efficiency, then turns to advanced vehicular technologies and fuels, new refrigerants (to replace CFCs, which, in addition to being implicated in the destruction of stratospheric ozone, are molecule for molecule more potent than carbon dioxide as greenhouse gases), and in-use emissions testing and travel reduction strategies. Finally, opportunities for continuation of the current (net) downward trend in fuel consumption by most non-highway transportation activities are described. The paper concludes that evolutionary developments in most transportation activities– developments driven in large measure by simple economics–could be at least as effective in mitigating the contribution of (domestic) mobile sources to "greenhouse warming" as any specific revolutionary change. 41 refs.

30461 (EC–90-02368) **Toward a common future: A report on sustainable development and its implications for Canada.** Keating, M. Environment Canada, Ottawa, ON (Canada). 1989. 50p. (MICROLOG–90-02368). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Environmental degradation, is recognized as one of the greatest challenges to the future. Canada began a national debate on sustainable development through the National Task Force on Environment and Economy, launched in 1986 by the Canadian Council of Resource and Environmental Ministers. This paper is a synopsis of issues that have been in the public debate on the future of the environment. The first section examines some of the major problems that must be dealt with, including climate change and the greenhouse effect, the ozone layer, acid and toxic rain, nuclear winter, chemicals, waste and garbage, cutting the forests, polluting surface and groundwater, and the destruction of habitat for other species. The second section describes some of the changes that will be needed to achieve sustainable development, such as developing non-polluting, sustainable energy sources, improving waste management, saving wildlands and wildlife, and population control. The implications of these changes for governments, business, public interest groups, education, and individual behaviour are also addressed. 24 refs., 2 figs.

30462 (LP/RB–BP198E) **Federal pollution legislation.** Backgrounder. Morrison, H. (Law and Government Div., Canada Library of Parliament, Ottawa, ON (Canada)); Niemczak, P. Canada Library of Parliament, Ottawa, ON (Canada). Research Branch. Jan 1989. 45p. (MICROLOG–90-01892). Available from PC Library of Parliament of Canada, Parliament Buildings, Ottawa, ON, CAN K1A 0A9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This background paper summarizes the Canadian federal legislation that regulates and prohibits pollution, generally understood to imply the contamination or disturbance of the environment by the emission or discharge of some noxious substance. The document begins with general legislation, describing the responsibility of the Department of the Environment, environmental quality objectives, guidelines and codes of practice, environmental assessment, criminal code offences, emergency measures, and federal works, lands and undertakings. Legislation dealing with toxic substances and hazardous waste is then considered, including water pollution, air pollution, and noise pollution. Some of the more important laws regulating pollution in the oil and gas industry, the nuclear industry, transportation, and agriculture are summarized.

30463 (MEW/RAC–90-00446) **Recycling; Now is the time!: Background paper.** Manitoba Dept. of Environment and Workplace Safety and Health, Winnipeg, MB (Canada). Recycling Action Committee. 25 Sep 1989. 11p. (MICROLOG–90-00446). Available from PC Manitoba Environment and Workplace Safety and Health, 450 Broadway Ave., Room 156, Legislative Bldg., Winnipeg, MB, CAN R3C 0V8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

In June 1989, a Recycling Action Committee was appointed by the Government of Manitoba to develop a comprehensive plan for promoting recycling and waste reduction in the province. This paper introduces the issues and background addressed by the Committee. The paper was drafted to stimulate input from the public, identify areas where there is agreement or disagreement, draw attention to aspects that should be investigated further, learn of ideas that should be pursued and learn about Manitobans' view of recycling. The paper defines the concept of recycling, the reasons for recycling and which materials can be recycled. The waste problem in the province, and why such materials cannot continue to be landfilled, is also addressed. The paper concludes with the economic aspects of recycling, various methods of recycling currently in use, and the legislation involved. A description of the components of the Recycling Action Plan to be developed is also given. 2 figs., 1 tab.

30464 (OWMC–90-01880) **Managing hazardous waste.** Ontario Waste Management Corporation, Toronto, ON (Canada). [1987]. 6p. (MICROLOG–90-01880). Available from PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This publication defines hazardous wastes, the various types produced and their impact on the environment. It then describes what hazardous wastes are produced in Ontario and the use of the reduction, reuse, recycling and recovery options for dealing with them. The publication concludes by describing the steps the province is taking to safely treat and dispose of the wastes. 2 figs.

30465 (PB–90-163148/XAB) **Environmental quality 1987-1988. The eighteenth annual report of the Council on Environmental Quality.** Council on Environmental Quality, Washington, DC (USA). 1988. 434p. Available from NTIS, PC A19/MF A03.

See also PB–88-181607.

The Environmental Quality report combines in one document an account of the activities of the Council on Environmental Quality and the developments under the National Environmental Policy Act for the calendar years 1987 and 1988. The report focuses on selected environmental conditions that are largely manmade and includes chapters on urban air quality, developed water resources and municipal solid waste; it also includes a chapter on the management of natural resources and environmental protection at defense installations, where conditions are affected by highly specialized and often intensive land uses. The report includes a chapter on the latest legal and administrative developments under the National Environmental Policy Act. The environmental quality report also includes a comprehensive set of statistical tables that corresponds to a forthcoming edition of CEQ's Environmental Trends source book.

30466 (PB–90-169988/XAB) **Environmental Research Laboratories Programs and Plans. FY 1989 programs and FY 1990 plans.** National Oceanic and Atmospheric Administration, Boulder,

CO (USA). Environmental Research Labs. Dec 1989. 175p. Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs. See also PB–88-176326.

The Environmental Research Laboratories (ERL) program is broad, embracing studies relating to the oceans and Great Lakes, the lower and upper atmosphere, and the solar-terrestrial environment. Studies and services focus in five subject areas: Weather, Climate, Air Quality, Ocean and Great Lakes, and Solar-Terrestrial Environment. The summary of ERL research is organized in terms of these subject areas. Succeeding sections discuss the accomplishments and plans of the individual Laboratories and their units. The appendix lists acronyms and initialisms used in all sections.

30467 (PB–90-172222/XAB) **Annual report on abandoned or uncontrolled hazardous-waste disposal sites and Hazardous Waste Remedial Fund, 1989. Appendix.** Iowa Dept. of Natural Resources, Des Moines, IA (USA). 1 Jan 1990. 242p. Available from NTIS, PC A11/MF A02.

See also PB–89-165443.

Section 455B.425 of the Code of Iowa requires the Director of the Department of Natural Resources to give a full account to the Legislature and the Governor each January 1st regarding the Hazardous Waste Remedial Fund. Section 455B.427 of the Code of Iowa requires the Director of the Department of Natural Resources to transmit a report to the Legislature and the Governor each January 1st regarding those sites listed on the Registry of Abandoned or Uncontrolled Disposal Sites. A copy of the report must also be sent to the board of supervisors of every county containing a site. This report is intended to fulfill both of these obligations.

30468 (PB–90-173964/XAB) **1989 annual report on abandoned or uncontrolled hazardous-waste disposal sites and Hazardous-Waste Remedial Fund.** Iowa Dept. of Natural Resources, Des Moines, IA (USA). 1 Jan 1990. 106p. Available from NTIS, PC A06/MF A01.

Section 455B.425 of the Code of Iowa requires the Director of the Department of Natural Resources to give a full account to the Legislature and the Governor each January 1st regarding the Hazardous Waste Remedial Fund. Section 455B.427 of the Code of Iowa requires the Director of the Department of Natural Resources to transmit a report to the Legislature and the Governor each January 1st regarding those sites listed on the Registry of Abandoned or Uncontrolled Disposal Sites. A copy of the report must also be sent to the board of supervisors of every county containing a site. The report is intended to fulfill both of these obligations.

30469 Manipulator mounted transfer platform. Dobbins, J.C.; Hoover, M.A.; May, K.W.; Ross, M.J. To U.S. Dept. of Energy, Washington, DC. USA Patent 4895488/A/. 23 Jan 1990. Filed date 12 Oct 1988. USA Patent Application 7-256,431. Int. Cl. B65G 63/00. vp.

The patent describes in a manipulator system for use in hazardous environments including a manipulator adapted for reciprocal movement upon a guide device, a transfer platform. It comprises: a bed frame defining a generally horizontal bed projecting outwardly from the manipulator; and frame mounting means securing the bed frame to the manipulator in a generally cantilevered fashion, thereby essentially minimizing the structure necessary to support the platform outwardly of the manipulator while enhancing operator visibility of the platform and the manipulator during use of the manipulator system.

2904 Energy Resources

Refer also to citation(s) 30097, 30186, 30188, 30192, 30207, 30213, 30259, 30260, 30491, 30507, 30511

30470 (EMR/EFA–90-02347) **2020 vision: Canada's long term energy outlook: Working paper.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). Energy and Fiscal Analysis Div. [1990]. 103p. (MICROLOG–90-02347). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Two oil price scenarios are developed, the first a reference case in which oil was at US$18/bbl-US$25/bbl by 2000 and flat thereafter, and an alternative case with prices at US$15/bbl-US$20/bbl by 2005, with a greater economic growth rate (by 15%) than under the reference case. The results are based on Energy, Mines and Resources Canada's inter-fuel substitution demand model, which incorporates the electricity-based utility generation expansion model, updated through 1987. Market share equations were re-estimated and some behavioural equations were re-specified. Policies and programs to deal with environmental objectives are included to only a limited extent; in general, the outlook does not reflect any significant changes in policy framework. The report examines the basic assumptions underlying the forecast, provides an analysis of the forecast results as they affect energy demand, looks at the supply side of the energy picture, and gives a brief overview of environmental issues. The results of the reference case suggest that, by 2020, secondary energy demand will be 90% higher than it is today, mainly electrical energy, but oil consumption is projected to be 66% higher than 1988 levels. Oil supply in 2020 will be 15% higher than the 1988 level, with most of the increase due to the development of bitumen projects, synthetic fuel plants and frontier projects. Despite increased production, Canada will become a net oil importer by 2010. Sufficient gas supplies are available to meet increasing domestic and export demand under both price scenarios. Canada's electricity generating capacity will double by 2020, with hydro's share 50% and nuclear's share 20%.

30471 (PB–90-180522/XAB) **Minerals Yearbook, 1988. Beryllium.** Kramer, D.A. Bureau of Mines, Washington, DC (USA). 1988. 10p. Available from NTIS, PC A02/MF A01.

Also available from Supt. of Docs.

Domestic production and consumption of beryllium ore decreased in 1988, but beryllium alloys garnered new applications in automotive electronics and increased their usage in computer systems. Following the significant increase in exports of beryllium in 1987, exports in 1988 returned to normal levels. Beryl ore imports declined significantly and reflected a decrease in apparent consumption. Contents include: Domestic data coverage; legislation and government programs; domestic production; consumption and uses; prices and specifications; foreign trade; world capacity; world review; and technology.

30472 (PB–90-180548/XAB) **Minerals Yearbook, 1988. Boron.** Lyday, P.A. Bureau of Mines, Washington, DC (USA). 1988. 12p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

U.S. production and sales of boron minerals and chemicals decreased during the year. Glass-fiber insulation was the largest use for borates, followed by sales to distributors, textile-grade glass fibers, and borosilicate glasses. California was the only domestic source of boron minerals. The report discusses the following: domestic data coverage; legislation and government programs; domestic production; consumption and uses; prices; foreign trade; world capacity; world review–Argentina, Chile, France, Italy, Turkey, United Kingdom; Technology.

30473 (PB–90-180563/XAB) **Minerals Yearbook, 1988. Cadmium.** Llewellyn, T.O. Bureau of Mines, Washington, DC (USA). 1988. 10p. Available from NTIS, PC A02/MF A01.

Also available from Supt. of Docs.

Cadmium metal production in the United States increased significantly in 1988, and four companies operating four plants produced all of the domestic cadmium. Imports for consumption of cadmium metal decreased, but exports increased. Dramatic increases in cadmium prices in 1988 were attributed to the tight supply of cadmium, heavy speculative trading, and the large quantities of cadmium being bought by the nickel-cadmium battery industry, particularly in Japan. The report discusses the following: Domestic data coverage; legislation and government programs; domestic production; consumption and uses; stocks; prices; foreign trade; world capacity; world review–France, Mexico; and Technology.

30474 (PIRSEM–2277) **Ecoenergy: scientifical report.** Dauphine, A. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM);

Nice Univ., 06 (France). 1987. 44p. (In French). Order Number DE90784635. Available from NTIS (US Sales Only), PC A03/MF A01.

Two simulation models of a regional ecological-energetical evolution are presented and discussed. Examples are given with flux results and parametic evaluation: energy resources, stock consumption, resource transfers, etc..

30475 (SERI/SP–220-3554) **Energy for today: Renewable energy.** Solar Energy Research Inst., Golden, CO (USA). Mar 1990. 25p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009461. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The United States is rich in renewable energy resources in the form of sunlight, wind, biomass, flowing water, geothermal energy, and ocean energy. Renewable energy plays a vital role in running our nation. Today, these resources provide about 9% of our domestic energy supply, and the contribution continues to grow rapidly. Renewable energy offers our nation several important advantages: As a resource entirely within our boundaries and under our control, renewable energy contributes to increased strategic and economic security; renewable energy is clean energy and provides a way to avoid the pollution associated with conventional energy technologies; renewable energy systems can be added in modular units to make our energy supply more flexible and reliable; and US renewable energy technology can help supply the world's growing demand for energy, which presents a tremendous export opportunity for American industry. This booklet reviews the contributions renewable energy is making today and highlights many successful applications. It also briefly describes the research programs sponsored by the US Department of Energy (DOE) that are the foundation of today's applications and will propel US technology into the 1990s. 54 figs.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 30046, 30186, 30191, 30193, 30211, 30212, 30457, 30509, 30527, 30553, 31063

30476 (EC/SEB–90-02366) **A decade of achievement: Environment and energy research & development.** Environment Canada, Hull, PQ (Canada). Science and Energy Branch. 1989. 58p. (MICROLOG–90-02366). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The federal Panel on Energy Research and Development's objectives are to provide, in conjunction with efforts in the private sector and by the provinces, the technical base for maintaining oil self-sufficiency, developing a diversified energy economy, and making Canada less reliant on non-renewable energy sources. The federal Energy R&D program is an interdepartmental program whose overall objective is to provide the science and technology for a diversified, economically and environmentally sustainable energy economy. The Panel is responsible for reviewing and coodinating the program and monitoring its products. This report describes major projects undertaken during the last 10 years. These include programs on all aspects of the environmental impact of exploring, operating and extracting petroleum reserves from the Western Basin, including the recycling of water used in the in situ heavy oil extraction process, and land treatment disposal of oilfield wastes. Programs dealing with the safe design of offshore oil and gas facilities include wind and wave hindcasting in the Beaufort Sea, icing on offshore structures, understanding ocean storms, and a remote-sensing monitor for spills. Programs in sustainable energy development include the appointment of a central carbon dioxide coordinator and flux measurement of gases in the atmosphere. Renewable energy programs concentrated on solar radiation data analysis, the development of the R-2000 home, a computer generated analysis of wind flow over a hill, and a Darrieus wind turbine at Cap-Chat. Demonstrations of resource and energy conservation include reuse of sewage sludge and of municipal solid waste, as well as research in the pulp and paper industry to increase internal energy production and decrease the total discharge of pollutants. 1 fig.

30477 (ORNL–6541/V2/P3) **Energy technology R&D: What could make a difference?: Volume 2: Part 3 of 3, Crosscutting science and technology.** Miller, J.T. (ed.). Oak Ridge National Lab., TN (USA). Dec 1989. 160p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010064. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Early in 1988, the management of Oak Ridge National Laboratory (ORNL) decided to organize an internal study to review the status of energy technologies and to identify the research and development opportunities that could make a difference for both the United States and the rest of the world. More than 100 ORNL staff members were organized into teams to review the status of technology in 18 areas covering energy use, energy supply, and crosscutting science. Each team attempted to identify significant technological advances that could be made within a reasonable time and cost. The results of the study are being published in two volumes. The first volume is the synthesis report, while the second volume is the collection of the 18 team reports. The three parts of Vol. 2 review (1) end-use technology, (2) supply technology, and (3) crosscutting science and technology. This part of Vol. 2 reviews crosscutting science and technology.

30478 (PB–90-104464/XAB) **Federal laboratory technology catalog 1989. A guide to new and practical technologies. Tech Notes annual index.** National Technical Information Service, Springfield, VA (USA). Center for the Utilization of Federal Technology. Mar 1990. 332p. Available from NTISPC$39.00.

See also PB–89-111132, PB–88-101969, PB–87-125688, PB–86-116167 and PB–85-106987.

The catalog presents summaries of practical technology developed by Federal laboratories. The items were selected for their commercial potential and/or promising applications to the fields of computer technology, electrotechnology, energy, engineering, life sciences, machinery and tools, manufacturing, materials, physical sciences, and testing and instrumentation. Each summary not only describes a technology, but more importantly, gives a source for further information. These sources include backup reports as well as personal contacts. The catalog includes some 1,000 new processes, inventions, equipment, software, and techniques developed by and for dozens of Federal agencies during 1987. Contributing agencies included NASA (NASA Tech Briefs), DOD, DOE, and many other leading sponsors of Federal R&D activity. This unique, single-volume collection of practical technology is arranged into 24 broad disciplines and includes a subject term index.

30479 (PB–90-104480/XAB) **Directory of federal laboratory and technology resources: A guide to services, facilities, and expertise. 1990-1991.** National Technical Information Service, Springfield, VA (USA). Center for the Utilization of Federal Technology. Jan 1990. 320p. Available from NTISPC$59.95.

Supersedes PB–88-100011 and PB–86-100344.

The unique Directory guides readers to hundreds of Federal laboratories willing to share their expertise, equipment–and sometimes even their facilities–to aid in U.S. research efforts. It contains detailed summaries, addresses, and telephone numbers of 1,100 resources including descriptions of 90 technical information centers. As a special feature, a complete list of all 300 plus Federal laboratory technology transfer offices is included. The catalog is divided into 31 subjects, making it easy to scan. Each entry includes a detailed technical summary and a contact name, address, and telephone number. Four indexes make it easy to locate resources: subject index; state index (arranges all the resources within a state); resource name index (provides a quick reference of the Federal laboratory of service); and an agency index.

30480 (TC–90-02159) **[Transport Canada] Energy research and development program: Status report 1988/89.** Transport Canada, Ottawa, ON (Canada). Sep 1989. 50p. (MICROLOG–90-02159). Available from PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN

K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Transport Canada's contribution to the federal government's Energy Research and Development program, administered by the multi-departmental Panel on Energy R&D, is directed at improving the energy efficiency and energy related environmental impact of all forms of transportation; promoting the understanding of problems and opportunities posed by the introduction of new forms of energy in transportation; and supporting the requirements for the transportation of energy commodities in frontier areas and in applications calling for advanced technologies. This annual report describes the work performed during the fiscal year 1988-89, funded under the specific programs of energy efficiency, tranportation of coal, alternative transportion fuels, and the transportation of oil and gas. Highlights include the monitoring of automotive and other transportation fuel consumption trends as a basis for future needs, possibly related to guidelines for improving environmental impact and leading to standards setting. Mathematical predictive fuel consumption models, fuel efficiency testing, and validation methodologies support this goal. A major concern for the energy efficiency program is to reduce barriers to wider conservation initiatives. Also emphasized is the assessing of the cost-effectiveness of new technologies designed to improve vehicle fuel economy. Particular attention is paid to the bus and truck sectors, as offering the best opportunity for concerted action in the Canadian context. Selected generic technology development is supported in the air, rail and marine sectors. 5 figs.

2906 Nuclear Energy

Refer also to citation(s) 30341, 30342, 30419, 30490

30481 (PB–90-139668/XAB) **Disclosure of atomic information to foreign governments and regional defense organizations. Directive.** Mills, K. Assistant Secretary of Defense (Atomic Energy), Washington, DC (USA). 24 Jul 1981. 10p. (DOD-D–5030.14). Available from NTIS, PC A02/MF A01.

The Directive reissues Department of Defense (DoD) Directive 5030.14, March 24, 1971, authorizes the Joint Atomic Information Exchange Group (JAIEG), and transmits the DoD/DoE Agreement that sets forth the policies and procedures governing disclosures of atomic information to foreign governments and regional defense organizations. Disclosures of classified military information that are not atomic information are governed by DoD Directive 5230.11.

30482 (PB–90-139684/XAB) **US nuclear test data preservation. Instruction.** Young, S. Office of the Under Secretary of Defense (Acquisition), Washington, DC (USA). 27 Apr 1987. 5p. (DOD-I–5015.3). Available from NTIS, PC A01/MF A01.

The Instruction establishes policy, assigns responsibilities, and prescribes procedures to preserve irreplaceable scientific data and technical information acquired during past U.S. and other nuclear weapons effects test exercises.

30483 (PB–90-139825/XAB) **DOD (Department of Defense) response to an accident or significant incident involving radioactive materials. Directive.** Larson, W. Office of the Under Secretary of Defense (Acquisition), Washington, DC (USA). 21 Dec 1989. 49p. (DOD-D–5100.52). Available from NTIS, PC A03/MF A01.

The Directive reissues DoD Instruction 5100.52 to: update guidance for planning and providing a DoD response in the event of an accident involving radioactive materials; promulgate DoD policy and planning guidance to implement the Federal Radiological Emergency Response Plan that describes the responsibilities of the Federal organizations that would respond to a radiological emergency, and specifies the radiological assistance responsibilities of the DoD. Reaffirm the responsibility of the DoD and provide guidance to DoD Components in matters involving State and local authorities; provide reporting guidance for use in the event of an accident involving nuclear weapons, nuclear components, nuclear reactors, or radioactive materials in the custody of or under the physical control of the DoD; recognize the authority and responsibility of the Director, Naval Nuclear Propulsion Program, for Naval nuclear propulsion matters; establish the DoD Radiation Detection Indication and Computation Working Group and the Joint Nuclear Weapon Accident Exercise Steering Group to improve DoD preparedness to respond to radiological emergencies.

30484 (PB–90-179425/XAB) **Nuclear accident and incident public affairs guidance. Directive.** Thomas, D. Assistant Secretary of Defense (Public Affairs), Washington, DC (USA). 7 Feb 1983. 21p. (DOD-D–5230.16). Available from NTIS, PC A03/MF A01.

The Directive reissues Department of Defense (DoD) Instruction 5230.16, August 8, 1967, to update DoD policies and procedures for the prompt release of information to the public in the interest of public safety and to prevent public alarm in the event of accidents or significant incidents involving nuclear weapons or radioactive nuclear-weapon components, radioactive material, and nuclear-capable systems, or nuclear reactors under DoD control.

30485 (SKN–30) **Opinions of the Swedish people on nuclear power and final disposal of nuclear wastes after Chernobyl.** Holmberg, Soeren (Goeteborg Univ. (Sweden). Dept. of Political Science). National Board for Spent Nuclear Fuel, Stockholm (Sweden). Oct 1988. 56p. (In Swedish). Order Number DE90627071. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Swedish public opinion, post-Chernobyl, on nuclear power and waste is analyzed and commented. The three main issues are: To what extent did the Chernobyl-accidendt influence the public opinion on nuclear power; How are the opinions on nuclear power connected to sex, age, political preferences; Should disposed high level nuclear waste be retrievable or not. The report is the result of several public opinion surveys. (L.E).

30486 (WZB-FS-II–88-303) **The public opinion of nuclear energy in the Federal Republic of Germany 1955-1986. A documentation.** Dube, N. Wissenschaftszentrum Berlin fuer Sozialforschung GmbH (WZB) (Germany, F.R.). 1988. 95p. (In German). Order Number DE90780272. Available from NTIS (US Sales Only), PC A05/MF A01.

With this report an attempt is made to document all opinion polls concerning the peaceful use of nuclear energy in the Federal Republic of Germany. This documentation is designed to serve as a useful tool for social science research. It should support the historical analysis of long-term developments in public opinion and a systematic comparison of questions asked in different polls and at different times. (orig.).

2910 Conservation

Refer also to citation(s) 30476, 30477, 30501, 30508, 30510, 30520, 30521, 30527, 30529, 30530, 30555, 30568, 30586, 30596, 30609, 30617, 30666

30487 (CMHC–90-02259) **[Canada Mortgage and Housing Corp.] Compendium of research, 1987/88.** Seshagirn, L. Canada Mortgage and Housing Corp., Ottawa, ON (Canada). 1989. 132p. (MICROLOG–90-02250). Available from PC Canada Mortgage and Housing Corporation, Annex Bldg., 682 Montreal Rd., Ottawa, ON, CAN K1A 0P7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Government of Canada provides funds to Canada Mortgage and Housing Corporation (CMHC) to conduct research into the social, economic and technical aspects of housing and related fields. This compendium of research lists reports produced under research programs sponsored by the Corporation during 1987/88. The document is arranged by broad subject area and consists of abstracts of CMHC research reports, reports produced under the external research program, operations support projects, and dissertations produced under the CMCH scholarship program. Detailed subject, author, and title indexes are included.

30488 (YEDT–CE02912) **Towards energy self sufficiency in the North: Energy conservation and forest biomass.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism,

Whitehorse, YT (Canada). [1985]. 447p. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

A symposium was held to address the issues of controlling energy demand through conservation, and increasing the range of energy supply using forest products (biomass) as a renewable alternative to fossil fuels in Canada's northern climates. Sections on retrofitting of thermal insulation, production of wood fuels, and unconventional energy analyses of these technologies are included. Separate abstracts have been prepared for 23 papers.

30489 Case study of the North Carolina Alternative Energy Corporation. Harris, L.R. (Dept. of Energy (US)); Duberg, J.A. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244–: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

In 1980 the North Carolina Utilities Commission and the six major electric utility organizations of the state established the North Carolina Alternative Energy Corporation (NCAEC). We are the Nation's only cooperative joint venture in energy between government and public and private power organizations. The AEC is a nonprofit corporation chartered to moderate the rate of growth in electric power demand and to defer the need to build expensive new central power plants. This case study is designed to provide a detailed understanding of why and how NCAEC was developed, how it operates and evaluates its programs, how it generates support for its undertakings, what problems and barriers it has had to overcome, and how it has tried to overcome these problems.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 30470

30490 (DOE/EIA–0035(90/01)) **Monthly energy review, January 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 25 Apr 1990. 135p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010030. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Monthly Energy Review presents current data on production, consumption, stocks, imports, exports, and prices of the principal energy commodities in the United States. Also included are data on international production of crude oil, consumption of petroleum products, petroleum stocks, and production of electricity from nuclear-powered facilities.

30491 (DOE/EIA–0202(90/2Q)) **Short-term energy outlook: Quarterly projections, April 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 1 May 1990. 47p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010699. Available from NTIS, PC A04/MF A01 - GPO - OSTI; GPO Dep.

The Energy Information Administration (EIA) quarterly forecasts of short-term energy supply, demand, and prices are revised in January, April, July, and October for publication. An annual supplement analyzes previous forecast errors, compares recent projections by other forecasters, and discusses current topics of the short-term energy markets. The principal users are managers and energy analysts in private industry and government. The projections in this volume extend through the fourth quarter of 1991. The forecasts are produced using the Short-Term Integrated Forecasting System (STIFS). The STIFS model is driven principally by the following sets of assumptions or inputs: forecasts of key macroeconomic variables, a particular set of world oil price assumptions, and assumptions about the severity of weather. The three featured projections for petroleum supply and demand are based on low, middle, and high economic growth assumptions coupled with high, middle, and low crude oil price trajectories, respectively, and various weather scenarios. The extreme weather cases are designed to replicate, quarter by quarter, the most severe weather conditions witnessed since 1975. The discussion and tables in this volume refer primarily to the middle, or base case, scenario and, unless otherwise noted, to the domestic situation. Table 7 summarizes the petroleum sensitivity cases and indicates the estimated effect of price, macroeconomic conditions, and weather on petroleum demand. 24 refs., 17 figs., 16 tabs.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 30228, 30343, 30381, 30460, 30461, 30495, 30551, 31415, 31416

2940 Fossil Fuels

Refer also to citation(s) 29935, 29944, 29957, 29982, 29983, 29994, 30012, 30013, 30017, 30019, 30020, 30029, 30030, 30031, 30032, 30033, 30037, 30046, 30056, 30057, 30058, 30061, 30070, 30071, 30074, 30078, 30093, 30094, 30458, 30490, 30491, 30952

30492 (DOE/FE–0171) **Public meetings for views and comments on the conduct of the 1990 clean coal technology solicitation, San Francisco, California, February 13, 1990; Boston, Massachusetts, March 1, 1990: Summary proceedings.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Apr 1990. 99p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008197. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Two public meetings were convened by the Department of Energy (DOE) in February and March 1990 in order to obtain views, comments, and recommendations with regard to the forthcoming Clean Coal Technology IV solicitation. In the sections that follow, brief descriptions are provided of the background to the CCT solicitation and the public meetings, and how the meetings were conducted. Subsequent chapters of this report present the discussions that ensued at each of the meetings, and the views, recommendations, and concerns that were expressed by attendees. Finally, the report includes a compilation of the written comments that were received, and, in the appendix, a list of the organizations that were represented at the public meetings.

30493 (DOE/FE–0173P) **Office of Coal Technology fiscal year 1990 program summary.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Apr 1990. 111p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90008211. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Broad research programs and goals under the office of coal technology are described. Programs include: atmospheric fluidized-bed combustion; pressurized fluidized-bed combustion; advanced combustion technology; alternative fuels; coal preparation; flue gas cleanup; waste management; heat engines program; coal-based gas stream cleanup; surface coal gasification; coal liquefaction; and clean coal technology demonstration program.

30494 Fuels to drive our future. 231p. National Academy Press, Washington, DC (1990). Sponsored by National Academy of Sciences/National Academy of Engineering/Institute of Medicine. DOE Contract FG01-89FE61694.

This report of the National Research Council's (NRC's) Committee on Production Technologies for Liquid Transportation Fuels addresses the problem of producing those fuels from domestic resources. Included in the report are economic analysis of the various technologies, an assessment of their state of development, and suggested strategic directions for a 5-year R&D program for producing liquid transportation fuels from plentiful domestic resources (see Chapter 6 for a more detailed summary of the report). There is growing interest in alternatives such as methanol and compressed natural gas. Concerted efforts are under way to understand better the consequences to human health, air pollution, and the greenhouse effect from the use of these fuels. While this report concentrates on R&D important to fuels production from domestic resources with priority given to lowest cost, it is recognized that choice of fuels, the feedstock for their manufacture, and fuel composition will be strongly influenced by these additional considerations. Thus, the R&D program should be flexible enough to anticipate and accommodate changes that may be required for environmental and other reasons. This viewpoint is reflected in the committee's recommendations. 110 refs., 15 figs., 15 tabs.

30495 (ECA–89-PA-CSS11) **Oil and gas in Alberta: An uncertain future: A discussion paper.** Environment Council of Alberta, Edmonton, AB (Canada). Energy and Non-renewable Resources Sub-committee. Oct 1989. 60p. (MICROLOG–90-02294). Available from PC Environment Council of Alberta, 8th Floor, Weber Centre, 5555 Calgary Trail, Edmonton, AB, CAN T6H 5P9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The demand for Alberta's oil and gas resources has been a major factor behind the province's economic growth in recent decades. The province has also experienced the effects of an economic recession when petroleum prices declined dramatically. This paper discusses Alberta's oil and gas resources, their development and economic significance, and the supply of and demand for these resources. Oil and gas reserves cannot be developed without interactions with other resources and resource users. These impacts are discussed, as well as the legislative framework within which development occurs. The paper concludes with a section on managing Alberta's non-renewable resources for the future and some ideas for an energy strategy. A glossary is included. 45 refs., 10 figs., 5 tabs.

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 30205, 30494

2960 Electric Power

Refer also to citation(s) 30216, 30219, 30293, 30296, 30317, 30431, 30432, 30456, 30490, 30521, 30570, 30613

30496 (BCH–90-01218) **BC hydro financial review 1989.** British Columbia Hydro, Vancouver, BC (Canada). [1990]. 33p. (MICROLOG–90-01218). Available from PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This financial review from B.C. Hydro presents highlights of the Crown corporation's financial performance for the current and previous 2 years, as well as its achievements of fiscal 1989 objectives. Explanations are given for income, including net income, revenues, transmission, and export sales; and for costs, including cost of energy, expenses, financial charges, financing and capital expenditure, and debt management. Regulatory and financial ratios, including rate stabilization and financial ratio are also explained. A comparison to other utilities in the areas of rates, unit costs, productivity, system reliability, and rate of return are better than average for Canadian utilities. An overview of the financial plan and objectives for 1990-92 concludes the report. Highlights include the third highest net income in the corporation's history, the first positive result from domestic operations since 1981.

30497 (DOE/EIA–0226(90/01)) **Electric power monthly, January 1990.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 24 Apr 1990. 182p. Sponsored by U.S. DOE Energy Information Administration. Order Number DE90010516. Available from NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.

The EPM is prepared by the Electric Power Division; Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration (EIA), Department of Energy. This publication provides monthly statistics at the national, Census division, and State levels for net generation, fuel consumption, fuel stocks, quantity and quality of fuel, cost of fuel, electricity sales, and average revenue per kilowatthour of electricity sold. Data on net generation are also displayed at the North American Electric Reliability Council (NERC) region level. Additionally, company and plant level information are published in the EPM on capability of new plants, net generation, fuel consumption, fuel stocks, quantity and quality of fuel, and cost of fuel. Quantity, quality, and cost of fuel data lag and net generation, fuel consumption, fuel stocks, electricity sales, and average revenue per kilowatthour data by 1 month. This difference in reporting appears in the national, Census division, and State level tables. However, at the plant level, all statistics presented are for the earlier month for the purpose of comparison.

30498 (EMR–CE02998, pp. 19) **Draft policy on purchase of electricity by B.C. Hydro in integrated and non-integrated areas.** Vanderkwaak, N. (B.C. Hydro, Vancouver, BC (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course*. Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

The purpose of this draft policy is to present British Columbia Hydro (BCH)'s current view on purchase of electricity from independent generators and to invite comments. A final policy will be issued by 1 October 1988. Under the proposed policy, BCH will purchase electricity from parallel generators on the integrated and non-intergrated system, provided that the price is lower than the cost of electricity from alternative sources. BCH will enter into purchase contracts of 20 years or more. Proposals will be called as required for purchases of electricity from projects on the integrated system with a capacity of 5 MW or more, or for projects on the non-integrated system. The purchase price and other conditions will be negotiated so as to benefit both the parallel generator and BCH. These financial arrangements could take the following forms: front-loaded prices, low interest loan, BCH grants, and cogeneration incentives, which include new tariffs or simultaneous buy-sell. To minimize transaction costs and to facilitate the development of parallel generation from projects on the integrated system with under 5 MW capacity, standard conditions will apply, and BCH will pay between 2.5¢/kWh and 3.0¢/kWh. In the spring of each year, BCH proposes to accept as much as 25 MW in blocks of less than 5 MW. Projects will be issued from time to time for service to specific non-integrated areas. Under certain conditions, wheeling services will be provided to parallel generators. The technical requirements as to the performance of parallel generators, and as to their interconnections with BCH's integrated or local systems, are discussed from the safety and reliability points of view. A short glossary of terms relevant to the purchase of electric power is provided.

30499 (EMR–CE02998, pp. 28) **Power sales and utility policy (Newfoundland).** Banfield, S.D. (Newfoundland and Labrador Hydro, St. John's, NF (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course*. Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

At present, the generation and distribution of electrical energy on the island portion of the Province of Newfoundland is shared among 5 different companies; in 1987, the load was distributed on a 60/40 basis between utilities and industries. Newfoundland and Labrador Hydro (NLH) has been granted exclusive rights for the development of hydro-electrical resources on the Island of Newfoundland, with the exception of those granted prior to the NLH Act. In Labrador, all water rights remain with the Crown, except for those associated with the development of the Lower Churchill River. In the Province of Newfoundland and Labrador, the Public Utilities Board regulates all the electrical rates related to the sales of electricity to utility customers, both on the Island and in Labrador. Since 1978, NLH has carried out a number of inventory studies to determine what hydro potential exists in both the isolated areas of the province suitable for isolated Diesel systems as well as sites close enough to the existing transmission grid to make their interconnection feasible; the results of these studies are summarized. The interconnection policy of NLH is summarized, and the process of negotiating and finalizing an agreement is outlined. In conclusion, NLH considers that most small-scale hydro power is not cost-effective unless some form of financial incentive is made available; the reliability of such

systems is not satisfactory at present. The appendices to the chapter comprise an information package for suppliers of electric power in non-interconnected areas, the requirements and terms of interconnection with NLH's isolated systems, and documents about the case of electricity generation in Westport, including the pricing and the contract for the delivery of electrical energy. 2 figs., 2 tables.

30500 (EMR–CE02998, pp. 6) **Summary of Ontario Hydro's parallel generation policy and procedures.** Petrella, A.J. (Ontario Hydro, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada). [1990]. (CONF-880711–: Canadian small hydro developers course and small hydro '88: international conference and trade show, Toronto (Canada), 4-9 Jul 1988; CE–02998). In *Canadian small hydro developers course*. Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

This chapter is a brief summary of Ontario Hydro's parallel generation policy and purchase conditions. The origins of Ontario Hydro, in 1906, from over 150 power generation facilities (owned by private companies, municipalities, and others) are recalled. For many years, the economies of scale have favoured large generation facilities, but, more recently, a revival of interest in parallel generation has resulted from new policies and programs of the Ontario government. Ontario Hydro currently has a corporate policy commitment to purchase power from private power producers in Ontario, subject to rate affordability and standard service conditions. This policy provides for 3 main activities: the purchase of power from parallel generators as a resource to the power system; the wheeling of power, for parallel generators, to other sites in Ontario owned by the parallel generator; and the provision of technical assistance. The guidelines for the main activity, power purchase, are listed. Purchase and contract conditions are discussed, both for projects up to 5 MV net power and above that value. The general requirements of Ontario Hydro for the connection of parallel generators are summarized. Ontario Hydro requires early notice of prospective projects, in order to accommodate orderly connection to the power system and preparation of the power purchase agreement. 1 fig.

30501 (EPRI-CU–6534) **Integrated value-based planning: An overview: Final report.** Chamberlin, J.H. (Barakat, Howard and Chamberlin, Inc., Oakland, CA (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Barakat, Howard and Chamberlin, Inc., Oakland, CA (USA). c Aug 1989. 43p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This primer was prepared to help planners understand the concepts of Integrated Value-based Planning. It discussed the IVP framework from three perspectives, and it provides examples of successful strategies already in place at utilities across the country. Many examples of potential new services are reviewed, ranging from options reflecting small changes in current programs to radically new concepts in utility service. This primer also highlights the results of EPRI's first Integrated Value-based Planning Conference held in December 1987. Drawing nearly 300 participants from around the country, this conference provided the first focused discussion of the IVP concept. The event served as an important vehicle to help EPRI define future research needs related to IVP, including specific short-term requirements for useful products and tools.

30502 (EPRI-CU–6728) **Scanning the external marketing environment: Special report.** Gellings, C.W.; Yau, T.S. Electric Power Research Inst., Palo Alto, CA (USA). c Apr 1990. 91p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

To meet the challenge of developing a responsive and broad-based end-use research program, EPRI's Customer Systems Division Committee has worked with staff over the last three years to develop data and to hold a series of workshops, the specific purpose of which was to develop a vision of the most probable futures in the 2000 to 2010 timeframe. The Division Committee examined the major issues that will affect the industry's end use program. Twelve major issues emerged from the examination and they were ranked by the Division Committee in the following order: capacity shortages and load factor degradation; competition between electricity and fossil fuels; global warming and acid rain; chlorofluorocarbon (CFC) ban; competition from non-utility generation; least cost planning; the changing customer; air quality and EMF; equipment manufacturers' reduced emphasis in R&D; gas research institute outspending EPRI in end-use R&D; US industry losses to foreign competitors; and the changing utility industry structure. A discussion of the background surrounding these issues, and their implications on the utility industry's end use programs are summarized in this report. 24 refs., 13 figs., 14 tabs.

30503 (EPRI-EM–5909) **Residential customer preference and behavior: Effective residential program design with PULSE®: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); National Analysts, Inc., Philadelphia, PA (USA); Synergic Resources Corp., Bala-Cynwyd, PA (USA); QEI, Inc., Davis, CA (USA). c Mar 1990. 31p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Utility success is tied to the development of programs that are effective and efficient. The residential PULSE system, described in this overview, can enhance a utility's ability to select, design, target, and competitively position successful programs. PULSE is a state-of-the-art, personal computer-based simulation tool that allows a utility to assess residential preferences and behavior and then estimate the market share potential for alternative programs and program configurations. The true value of residential PULSE lies in its proven ability to enhance the quality of utility program decisions. 53 figs.

30504 (EPRI-EM–6135-Rev.1) **Foodservice sourcebook: A quick-reference guide to industry information and sources: Final report: Revision 1.** Electric Power Research Inst., Palo Alto, CA (USA); Whiddon (W.I.) and Associates, Inc., Winchester, VA (USA). c Feb 1990. 130p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The purpose of this project was the development of a comprehensive, easily-updated sourcebook of information and references related to the foodservice industry for use by electric utility customer service staffs. The "Foodservice Sourcebook" consists of the following directories: (1)Foodservice Industry Leaders — Leading Foodservice Operators (Fast Food; Full Service; Lodging; Diversified Restaurant, Cafeteria and Retail Chains, Transportation and Recreation Foodservice Operators; Contract Management Firms; Franchises; Parent and Subsidiary Company Finders; Institutional, Military, School, and Healthcare Foodservice Organizations; Independent Restaurant Operators), and Foodservice Trade and Restaurant Associations; (2) Equipment Manufacturer Directories — Broilers; Fryers; Griddles; Hot Water Heaters; Ovens; Ranges; Refrigerators and Freezers; Steamers and Skillets; Ventilation and Exhaust Equipment; Warewashers; Leading Major Equipment Distributors; (3) Electric Utilities — National Electric Customer Assistance Network; Electric Utility Foodservice Activities (Commercial Cooking, Test/Demonstration Kitchen, Equipment Efficiency Improvement, Lighting, Hot Water, Space Conditioning, and Refrigeration electric utility programs); (4) Foodservice Market Trends — Excerpts from "Restaurant Business: Restaurant Growth Index," September, 1989; (5) Foodservice Design/Operation Guide — Excerpts from National Restaurant Association Facilities Operations Manual; and (6) Reference Bibliography — Electric Power Research Institute, National Restaurant Association, and industry publications.

30505 (ORNL/FTR–3602) **[Preparations for a major international symposium on electricity and the environment]: Foreign trip report, March 31, 1990–April 7, 1990.** Wilbanks, T.J. Oak Ridge National Lab., TN (USA). 27 Apr 1990. 16p. Sponsored by International Atomic Energy Agency. DOE Contract AC05-84OR21400. Order Number DE90010539. Available from NTIS, PC A03/MF A01 - OSTI.

At the request of eleven international agencies and with the approval of the Department of Energy, this trip was conducted in order for the traveler to serve as US representative to an international advisory group on "energy and electricity supply and demand." This group was established to assist with preparations

for a major international Symposium on Electricity and the Environment, scheduled for Helsinki, Finland, in May 1991. At the meeting, the topics of energy and electricity supply and demand patterns, projections, and issues; issue and background papers to be prepared for the Symposium; and Symposium program and participation were discussed.

2980 Consumption and Utilization

Refer also to citation(s) 30491, 30517, 30559, 30562, 30563, 30565, 30601

30506 (AFME-FR–7) **Compilation of energy data (1975-1986) for Guadeloupe, Martinique, Guyane and Reunion.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 73p. (In French). Order Number DE90784621. Available from NTIS (US Sales Only), PC A04/MF A01.

Economical data and energy consumption data are presented in tabular form and graphics for four french overseas territories: energy sources, energy demand and supply, energy consumption in the industrial, services, domestic and transportation sectors; the various types of energy are: fiel oil, car gasoline, aircraft gasoline, electricity, geothermal, solar, hydroelectric energy and biomass (bagasse...).

30507 (DOE/EIA–0214(88)) **State energy data report: Consumption estimates, 1960–1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Energy Markets and End Use. 30 Apr 1990. 472p. Sponsored by U.S. DOE Management & Administration. Order Number DE90010700. Available from NTIS, PC A20/MF A01 - GPO - OSTI; GPO Dep.

This volume is an annual report for 1988 by the Energy Information Administration giving energy consumption for each state. A summary is given for the USA as a whole. Consumption is broken down to transportation, industrial, and residential sectors. (FSD)

30508 Trends in household energy conservation attitudes and behaviors in the Northwest: 1983-1987. . Schultz, R.W. (Pacific Northwest Lab. (US)). vp. of Behavior and lifestyle. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808250–: Behavior and lifestyle, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This report presents the results of a 1987 telephone survey of attitudes and behaviors toward energy conservation and compares them with the results of similar surveys fielded in 1983 and 1985. Asked to rate major socioeconomic issues about which they were very concerned, survey respondents indicated the following, ranked in descending order: crime, cost of energy, inflation, energy conservation, unemployment, and energy use in the home. Concern over energy-related issues has generally remained at a constant level over the study period. Respondents believe that investing in energy conservation saves them money and enhances the comfort and value of their homes.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 30189, 30209, 30488

30509 (PAI–CE02993) **Renewable energy research and development workshop.** Passmore Associates International, Ottawa, ON (Canada). [1990]. 78p. (CONF-8510517–: Renewable energy research and developement workshop, Montebello (Canada), 21-22 Oct 1985; CE–02993). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In October 1985, 26 questions were put to 70 specialists from the private sector, universities and other institutions, and government and other public bodies on the subject of 5 renewable energy sources: wind power, passive solar power, small hydroelectric power, active solar power, and photovoltaic power and also on the subject of multidisciplinary research is support of these energy sources. The results of this panel discussion are summarized in the present report. The general conclusions of the discussion are that: there is a need, for the federal Canadian Ministry of Energy and Mineral Resources (EMR), to establish specific goals for each technology; administrative procedures should be simplified; there is a need for continuity and long-term contracts and a need to support Canadian content in the research and development; there should be no limit to government funding; the role of the technology-specific advisory committees should be expanded; at least 1 contact person at EMR should specialize in each technology area; information dissemination should be improved. It was recommended that even with up to 75% of government funding, the intellectual property of the results should still reside with the private sector. 8 tabs.

30510 (YEDT–CE02912, pp. 21-31) **The need for innovative community financial strategies that offset the failure of price to optimize conservation investments.** Laitner, S. (Community Action Reasearch Group, Ames, IA (USA)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Despite the mounting evidence of the benefits of conservation and renewable energy technologies, financial investments continue to be directed toward conventional energy supplies. A major reason for this situation is that energy prices are biased in favor of using fossil and nuclear fuels. Price comparisons offer only a single dimensional look at the full economic impacts that result from an expenditure for a given energy technology. For these reasons, other economic measures should be explored in determining optimal energy investments in the future. One such measure is the multiplier effect which refers to the fact that when money is spent for a specific good or service within a community, a demand for labor and materials is created which, in turn, ripples through the economy and multiplies the value of the original expenditure. Evidence suggests that even when the price for conservation and renewable energy technologies are higher than for conventional fuels, investments in the former tend to produce a larger economic return to the community. With this type of economic analysis, businesses and public policy makers can devise financial arrangements that enable a community to take advantage of an energy conservation investment even when life-cycle costs appear to be higher. 9 refs., 2 tabs.

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

Refer also to citation(s) 30511

3003 Thermoelectric Generators

30511 (JPL-D–6846) **Direct conversion technology: Annual summary report CY 1989: Energy Conversion and Utilization Technologies Program.** Massier, P.F.; Bankston, C.P.; Williams, R.; Underwood, M.; Jeffries-Nakamura, B.; Fabris, G. Jet Propulsion Lab., Pasadena, CA (USA). 4 Dec 1989. 56p. Sponsored by U.S. DOE Conservation & Renewable Energy; National Aeronautics and Space Administration. DOE Contract AI01-86CE90237. Order Number DE90010057. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The overall objective of the Direct Conversion Technology task is to develop an experimentally verified technology base for promising direct conversion systems that have potential application for energy conservation in the end-use sectors. This report contains progress of research on the Alkali Metal Thermal-to-Electric Converter (AMTEC), and on the Two-Phase Liquid-Metal MHD Electrical Generator (LMMHD) for the period January 1, 1989 through December 31, 1989. Research on these concepts was initiated during October 1987. Reports prepared on previous occasions contain discussions on the following other direct conversion concepts:

thermoelectric, pyroelectric, thermionic, thermophotovoltaic, thermoacoustic, thermomagnetic, thermoelastic (nitinol heat engines); and also, more complete discussions of AMTEC and LMMHD systems. 4 refs., 23 figs.

3004 Thermionic Converters

30512 (GA-A–19876) **TFE Verification Program: Semiannual report for the period ending September 30, 1989.** General Atomics, San Diego, CA (USA). Mar 1990. 148p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-86SF16298. Order Number DE90008227. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The objective of the semiannual progress report is to summarize the technical results obtained during the latest reporting period. The information presented herein will include evaluated test data, design evaluations, the results of analyses and the significance of results. The program objective is to demonstrate the technology readiness of a TFE suitable for use as the basic element in a thermionic reactor with electric power output in the 0.5 to 5.0 MW(e) range, and a full-power life of 7 years. The TF Verification Program builds directly on the technology and data base developed in the 1960s and 1970s in an AEC/NASA program, and in the SP-100 program conducted in 1983, 1984 and 1985. In the SP-100 program, the attractive but concern was expressed over the lack of fast reactor irradiation data. The TFE Verification Program addresses this concern. The general logic and strategy of the program to achieve its objectives is shown on Fig. 1-1. Five prior programs form the basis for the TFE Verification Program: (1) AEC/NASA program of the 1960s and early 1970; (2) SP-100 concept development program;(3) SP-100 thermionic technology program; (4) Thermionic irradiations program in TRIGA in FY-86; (5) and Thermionic Technology Program in 1986 and 1987. 18 refs., 64 figs., 43 tabs.

3005 Fuel Cells

Refer also to citation(s) 29981, 30306, 30450

30513 (SV-US–1989-41) **Fuel cell for electric power and heat production: Status of development 1989.** Carlstedt, N.E.; Spante, L. Swedish State Power Board, Vaellingby (Sweden). 15 Nov 1989. 79p. (In Swedish). Order Number DE90770777. Available from NTIS (US Sales Only), PC A05/MF A01.

Vattenfall has during 1989 studied the status of the fuel cell development with concentration on MCFC and PAFC technology. This report discusses the technical status, system configurations, economy and development programs for the most interesting fuel cell technologies for cogeneration and electric power plants. Gasified biomass and methanol could be environmentally interesting fuels for fuel cell cogeneration plants in the Swedish eneryg system. A rough economic estimation of the MCFC-technology in a Swedish cogeneration system shows that the total cost could be on the same level as for conventional systems. However, based on the same demand of heat the production of electricity will be much larger. This fact together with good environmental characteristics indicate that MCFC-systems could be competitive.

30514 Cathode for molten carbonate fuel cell. Kaun, T.D.; Mrazek, F.C. To U.S. Dept. of Energy, Washington, DC. USA Patent 4891280/A/. 2 Jan 1990. Filed date 25 Apr 1986. USA Patent Application 6-855,548. Int. Cl. H07M 4/86. vp.

This patent describes a porous sintered cathode useful for a molten carbonate fuel cell comprising a sintered mixture and electrolyte. The sintered mixture being of a first particulate material slightly soluble in the electrolyte present in the molten carbonate fuel and a second particulate material insoluble in the electrolyte, present in the molten carbonate fuel cell. The first material forming a skeletal structure coated by particles of the second material, the first and second particulate materials initially having average diameters not greater than about 10 microns. The sintered mixture having a porosity in the range of from about 60% to about 70% by volume at steady-state cell operating conditions and including macro-pores in the range of from about 25 to about 50 microns and micropores of about 0.1 microns.

30515 Electrode assembly for use in a solid polymer electrolyte fuel cell. Raistrick, I.D. To Dept. of Energy, Washington, DC. USA Patent 4876115/A/. 24 Oct 1989. Filed date 3 Mar 1988. USA Patent Application 7-163,672. Int. Cl. H10M 4/86. 8p.

This paper describes a gas reaction fuel cell provided with a solid polymer electrolyte membrane. Porous gas diffusion electrodes are formed of carbon particles supporting a catalyst which is effective to enhance the gas reactions. The carbon particles define interstitial spaces exposing the catalyst on a large surface area of the carbon particles. A proton conducting material, such as perfluorociarbon copolymer or ruthenium dioxide contacts the surface areas of the carbon particles adjacent the interstitial spaces. The proton conducting material enables protons produced by the gas reactions adjacent the supported catalyst to have a conductive path with the electrolyte membrane. The carbon particles provide a conductive path for electrons. A suitable electrode may be formed by dispersing a solution containing a proton conducting material over the surface of the electrode in a manner effective to coat carbon surfaces adjacent the interstitial spaces without impeding gas flow into the interstitial spaces.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

30516 (AFME-FR–19) **Research and Development at the AFME.** Chartier, P. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 17p. (In French). Order Number DE90784631. Available from NTIS (US Sales Only), PC A03/MF A01.

The AFME (Energy Conservation French Agency) research and development strategy is reviewed. The energy conservation rate in France is compared to the rate in other developed countries. The main research and innovation sectors supported by AFME are the rational use of energy in industry, the development of renewable energies, and the management/conservation of raw materials. Examples are given.

30517 (CONF-8910395–1) **Roles of energy efficiency in reducing environmental impact.** Schertz, W.W. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Illinois energy conference; Chicago, IL (USA); 20 Oct 1989. Order Number DE90010413. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is a paper presented by William W. Schertz of Argonne National Laboratory to the Illinois Energy Conference in Chicago on October 20, 1989. The paper discusses ways in which energy efficiency has enhanced environmental quality. 4 refs., 4 figs. (FSD)

3201 Buildings

Refer also to citation(s) 30023, 30024, 30025, 30027, 30210, 30260, 30261, 30262, 30263, 30264, 30266, 30487, 30488, 30576, 30610, 30978, 31414, 31415

30518 (CICS–CE02996, pp. 33-36) **The development of a high efficiency gas fired water heater.** Preto, F. (Energy Research Laboratories, CANMET, Ottawa, ON (Canada)); Hayden, A.C.S.; Smith, R.W.; Ferenczy, T. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This paper describes the design of a new unit which combines the positive aspects of the instantaneous water heaters (high output burner, electronic ignition, side wall venting) and the storage capacity of a well-insulated tank. To these features are added a balanced flue and a secondary finned tube heat exchanger to produce a high efficiency condensing water heater. The addition of a highly insulated storage tank means that peak demands may be

easily satisfied without extremely high firing rates. This condensing water heater system has been designed which substantially increased efficiency over conventional water heaters. In addition, due to its balanced flue design, the system does not consume indoor air for combustion. The flue gas path is completely isolated from the indoor environment and venting is assured by an induced draft fan, thus making the unit suitable for air-tight housing. It operates at recovery efficiencies approaching 90% and standby losses of less than 8%, thereby yielding a seasonal efficiency in the 80% range, compared to 50% for a conventional gas-fired water heater. 1 ref, 2 figs.

30519 (DOE/CE/15256–1) **Rotary absorption heat pump sensitivity analysis: Final report.** Bamberger, J.A. (Pacific Northwest Lab., Richland, WA (USA)); Zaloudek, F.R. Conserve Resources, Inc., Prescott, WA (USA); Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 84p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-86CE15256. Order Number DE90010006. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Conserve Resources, Incorporated is currently developing an innovative, patented absorption heat pump. The heat pump uses rotation and thin film technology to enhance the absorption process and to provide a more efficient, compact system. The purpose of this report is to present the results of a sensitivity analysis of the rotary absorption heat pump (RAHP) performance conducted to further the development of a 1-ton RAHP. The objective of the uncertainty analysis was to determine the sensitivity of RAHP steady-state performance to uncertainties in design parameters. Prior to conducting the uncertainty analysis, a computer model was developed to describe the performance of the RAHP thermodynamic cycle. The RAHP performance is based on many interrelating factors, not all of which could be investigated during the sensitivity analysis. Confirmatory measurements of $LiBr/H_2O$ properties during absorber/generator operation will provide experimental verification that the system is operating as it was designed to operate. Quantities to be measured include: flow rate in the absorber and generator, film thickness, recirculation rate, and the effects of rotational speed on these parameters. 3 refs., 3 figs., 5 tabs.

30520 (DOE/RL/01830–P-H4-Vol.1) **Architect's and engineer's guide to energy conservation in existing buildings: Volume 1, Energy use assessment and simulation methods.** Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 91p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90008226. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This first volume serves as a resource for federal energy managers to assist them in understanding and undertaking energy conservation projects. This volume is a general overview or preview on energy conservation general, while the second volume deals with 118 specific energy conservation opportunities (ECOs). Chapter 1.0 is an introduction to the Federal Energy Management Program (FEMP), as well as overview of this two-volume guide. Chapter 2.0 presents background information on characteristics of the federal buildings sector and reviews pertinent federal legislation concerning energy conservation. Chapter 3.0 provides guidance on how to assess energy use in federal facilities. Included in Chapter 3.0 is a discussion of analysis of utility bills, screening for energy conservation opportunities, analysis of promising opportunities, and identification of supplemental metering needs. With the increasing use of computers, especially personal computers, many building simulations or models are now available to aid energy managers or architects/engineers in analyzing ECOs. Chapter 4.0 discusses the evolution of these diverse computer simulation models, the typical data input needed to use these models effectively, how to use the models, the typical data input needed to use these models effectively, how to use the models for ECO analysis, and how to interpret the model results. The last section of Chapter 4.0 discusses some of the limitations associated with using computer models in ECO analysis. 11 refs., 1 fig., 10 tabs.

30521 (DOE/RL/01830–P-H4-Vol.2) **Architect's and engineer's guide to energy conservation in existing buildings: Volume 2, Energy conservation opportunities.** Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 215p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE90008212. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This second volume of the Architect's and Engineer's Guide to Energy Conservation in Existing Buildings serves as a handbook for energy managers to assist them in deciding which energy conservation opportunities (ECOs) to pursue. While the first volume of the set deals in general with ECOs, this volume details specifics concerning 118 ECOs, including how to implement the ECO, the information required to analyze the ECO, and the use of a personal computer model, ASEAM, to analyze each ECO. The 118 ECOs discussed in Chapter 1 and analyzed in Chapter 2 fall into the following eight categories: building equipment operation, building envelope, HVAC systems, HVAC distribution systems, water heating systems, lighting systems, power systems, and miscellaneous ECOs that do not fall into the other categories. The two-volume guide is based on research performed by Pacific Northwest Laboratory for the Federal Energy management Program within the Office of Conservation. 33 refs., 18 figs., 32 tabs.

30522 (GKYA–86-6258) **Development and demonstration of calibrated modelling as a technique to evalute the performance and cost effectiveness of passive solar office building systems.** Yuill (G.K.) and Associates Ltd., Winnipeg, MB (Canada). 30 Sep 1987. 73p. Contract EMR 23216-6-6258/01-SZ. (MICROLOG–89-06354). Available from PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The development and demonstration of a technique to evaluate the performance of passive solar office buildings by calibrated modelling, begun in a previous report, was completed in this project. The previous report described the monitoring of a low-rise passive solar office building, and the initial development of a BLAST (Building Loads and System Thermodynamics) computer model of the building. The BLAST model was refined in this project so that it provided thermal performances similar to that of the monitored data. The model was run for a year of data in its original configuration and in a configuration with some of the passive solar elements removed. The contribution to the building space heating from the passive solar elements (insulated panels) was found, and an economic analysis performed to evaluate the benefit of these elements. It was found that the saving in heating energy was ca 250 kWh/y, with a value of $9,00. The payback period for the panels would then be about 90 years. Calibrated modelling can provide a technique to develop a building model with accuracy that is difficult to attain with any other technique. However, this technique also requires a substantial amount of effort to complete, and may be more suitable as a research tool than a design aid. 1 ref., 22 figs., 1 tab.

30523 (IBP-EB–20/1988) **The energy-saver test house in Munich. Results of a three-year study of a lived-in single-family home (older building).** IRB-Forschungsbericht. Werner, H.; Lindauer, E. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.). 1988. 42p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

Commissioned by the Munich Public Utility Company a three-year research program was started in 1985 in order to determine heating and building measures by which energy saving can be achieved in old buildings. During the first heating season the original condition of the house was used as a standard of reference. In the next heating season one looked at the effects of the new heating system and in the third year one concentrated on the effect of insulating the outer walls of the building. By comparing the saving effect of the various periods it was possible to determine which energy saving measures were most important. With energy prices being low energy saving today does not just mean to save money but to make a contribution to the protection of the environment by reducing the emission of pollutants. The report describes the original conditions (phase 1) energy-saving measures carried out in phase 2 and 3 and construction measures (3). The measuring program and the results of the 3 phases are described. (BR).

30524 (IRTA–CE02941) **Installation and monitoring of a TP 2000-30kW stoker: Final report.** LeMay, C.; O'Connor, G. I.R.T.A. (Inst. de Recherche en Technologie Appropriee), Clarence Creek, ON (Canada). Jun 1988. 41p. Contract EMR 23216-6-6260/01-SZ. (CE–02941). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST.

A TP 2000-30kW chip-fired stoker was installed and monitored over the 1987-1988 winter in a 140 sq.meter (1500 sq.ft) farmhouse, near Rockland, Ontario. The stoker was connected to a Hunter Enermax furnace serving as a heat exchanger. It was fueled with hardwood pulpmill quality chips at an average moisture content of 35% (wet base). With the hold-fire mode set at its maximum, the system efficiency was of 49%, delivering an average of 18.6 MJ/h over the months of January, February and March. Reducing the hold-fire mode to its lowest adjustment would have increased the system efficiency to 59%. Operating full time, the system was capable of delivering over 40 MJ/h, as installed. Adjusted for maximum output, in optimum laboratory conditions, this system is capable of three times this peak output. The installation was practically creosote-free and operated without any major problems. 14 figs., 3 tabs.

30525 (NRC/IRC–28134) **Natural convection in the cavity of a basement block wall.** Svec, O.J.; Goodrich, L.E. National Research Council of Canada, Saskatoon, SK (Canada). Inst. for Research in Construction. Oct 1986. 11p. (MICROLOG–90-00163). Available from PC Canada Institute for Scientific and Technical Information, Montreal Rd, Ottawa, ON, CAN K1A 0R6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $3.00 CAN; MF $10 CAN.

A full scale experimental programme to study the adfreeze/heaving problem of an insulated basement is currently underway at an experimental house in Ontario. This experiment has also yielded interesting findings related to the natural convection in concrete-block wall cavities. Both the field data and a simplified finite element model calculation show that natural convection in a block basement wall can be a significant factor contributing to heat losses. Insulating only the side upper portion of the wall, as is current practice, may not be effective in reducing heat losses with block walls, while full length insulation may lead to significant lowering of ground temperatures near footing levels. 9 refs., 5 figs.

30526 (ORNL/FTR–3561) **[Meetings to share advancements in heat pump technologies]: Foreign trip report, March 6–20, 1990.** Creswick, F.A.; DeVault, R.C.; Fairchild, P.D. Oak Ridge National Lab., TN (USA). 4 Apr 1990. 25p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010008. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Conference brought together researchers, engineers, managers, and government policy makers from the various participating countries and provided a forum to share information on heat pump technological advancements and related environmental issues. From interactions with the Japanese participants in various working meetings and site visits, it is clear that heat pumps represent a major technology emphasis in Japan for industry and utility supported R&D, as well as government-sponsored programs. The Super Heat Pump (SHP) project sponsored by the Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI) and aimed at leveling electric power demand in addition to higher heat pump performance, is a notable example of this emphasis and of the way in which industry, research institutes, and government are working together in Japan. A joint industry R&D association established for the SHP effort, for example, includes sixteen (16) major corporate members (Mitsubishi, Toshiba, etc.). Also, gas-fired heat pumps have moved beyond laboratory prototypes and field tests and have emerged in Japan in production quantities. These first market entry products use "near conventional" small I.C. engines and are sized for residential and small commercial building applications. Sales are already in the ten thousands annually, and are increasing. Four major companies are already manufacturing and marketing such units – Yamaha, Yanmar, Aisin Seiki, and Sanyo. The Japanese companies and research organizations were much more open and frank about their research activities and progress than anticipated. The new Heat Pump Technology Center of Japan (HPTCJ) was an excellent host and established a positive atmosphere for international dialogue and cooperation.

30527 (ORNL/M–1133) **Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE Office of Buildings and Community Systems: Monthly progress report, March 1990.** Burn, G. (comp.). Oak Ridge National Lab., TN (USA). Mar 1990. 46p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90008216. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Monthly Report of the Building Thermal Envelope Systems and Materials (BTESM) Program is a monthly update of both in-house ORNL projects and subcontract activities in the research areas of building materials, wall systems, foundations, roofs, building diagnostics, and research utilization and technology transfer. Presentations are not stand-alone paragraphs every month. Their principal values are the short-time lapse between accomplishment and reporting and their evolution over a period of several months.

30528 (PB–90-169053/XAB) **Development of high-efficiency scroll compressors for heat pump air conditioners.** Hirano, T.; Hagimoto, K.; Matsumura, N.; Hori, M.; Takeda, K. Mitsubishi Heavy Industries Ltd., Tokyo (Japan). c 1989. 8p. Available from NTIS, PC A04/MF A01.

Pub. in Technical Review, Vol. 26, No. 3, 166-172(1989).

As for recent heat-pump air conditioners, compressors are required to operate in a wide speed range by means of inverter drive and wide operating pressure range. From the points of high efficiency, high reliability, etc., scroll compressors have recently been used. To accomplish high efficiency, self-sealing mechanisms such as tip-seal and swing-link mechanisms are very effective. The authors have developed high-efficiency hermetic scroll compressors with self-sealing mechanisms. These scroll compressors have capacity control function and can be driven by an inverter. The report describes the characteristics of global performance simulation that was developed for scroll compressor analysis and experimental studies of the internal behavior of scroll compressors.

30529 (PB–90-171448/XAB) **Windows: Technical paper with comments.** Woods, W. Architectural and Transportation Barriers Compliance Board, Washington, DC (USA). Sep 1984. 88p. Available from NTIS, PC A05/MF A01.

Functional requirements of windows are examined including window location; hardware design, operation, and placement; energy conservation needs; and egress requirements. Basic window styles and design characteristics are described. Problems confronting persons with disabilities are identified and recommendations are made on the development of minimum functional and safety specifications for windows.

30530 (PB–90-862087/XAB) **Energy conservation through building design. October 1984-February 1990 (a Bibliography from the NTIS data base). Report for October 1984-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 136p. Available from NTISPC N01/MF N01.

Supersedes PB–89-861710.

This bibliography contains citations concerning methods and equipment used in the design of residential and commercial buildings to decrease energy consumption. Topics include energy conservation program descriptions and the use of alternative energy sources and building designs in retrofitting existing buildings and new construction. Methods of calculating and computing envelope thermal loads and payback periods are presented. (This updated bibliography contains 240 citations, 54 of which are new entries to the previous edition.)

30531 (PB–90-862129/XAB) **Thermal insulation for residential homes. September 1982-May 1986 (a Bibliography from the NTIS data base). Report for September 1982-May 1986.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 158p. Available from NTISPC N01/MF N01.

See also PB–90-862137.

This bibliography contains citations concerning materials and methods used for thermal control of residential buildings. The thermal efficiency of window glass, cellular materials, glass wool, fibers, wood, foams, and other insulating materials are reviewed. Construction methods and location of the house are also discussed. (This updated bibliography contains 329 citations, none of which are new entries to the previous edition.)

30532 (PB–90-862137/XAB) **Thermal insulation for residential homes. June 1986-February 1990 (a Bibliography from the NTIS data base). Report for June 1986-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 80p. Available from NTISPC N01/MF N01.

Supersedes PB–86-869039. See also PB–90-862129.

This bibliography contains citations concerning materials and methods used for thermal control of residential buildings. The thermal efficiency of window glass, cellular materials, glass wool, fibers, wood, foams, and other insulating materials are reviewed. Construction methods and location of the house are also discussed. (This updated bibliography contains 139 citations, all of which are new entries to the previous edition.)

30533 (PWC/AES–1-4:86-17) **Project manager's guide.** Building performance evaluation series, Document A1. Public Works Canada, Ottawa, ON (Canada). Architectural and Engineering Services. [1990]. 22p. (MICROLOG–90-02169). Available from PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This document is an introduction to building performance evaluation and a guide to using the entire building performance evaluation series in managing capital projects. Building performance is the sum of how a building functions in the environmental and energy area, the functional area, and the systems and material area. The evaluation of building performance plays an important part in developing and managing real property. 1 fig.

30534 (PWC/AES–1-4:86-18) **Property manager's guide.** Building performance evaluation series, Document A2. Public Works Canada, Ottawa, ON (Canada). Architectural and Engineering Services. [1990]. 20p. (MICROLOG–90-02168). Available from PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This document is an introduction to building performance evaluation and a guide to how the entire building performance evaluation series can be used in managing real property. Building performance covers environmental and energy performance, functional performance, and systems and material performance and evaluation involves the testing of one or more of these attributes. 1 fig.

30535 (PWC/AES–1-4:86-20) **Catalogue of tests.** Building performance evaluation series, Document B1. Public Works Canada, Ottawa, ON (Canada). Architectural and Engineering Services. Mar 1988. 39p. (MICROLOG–90-02180). Available from PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This document is an index for all the test methodologies that are in the Class D documents of the building performance evaluation series. The catalogue lists the purpose and technique used for each test methodology and locates the specific test within the Class D document series of environmental and energy performance, functional performance, and systems and material performance. 2 figs.

30536 (PWC/AES–1-4:86-45) **Airtightness and pressure monitoring.** Building performance evaluation series, Document D36. Public Works Canada, Ottawa, ON (Canada). Architectural and Engineering Services. Mar 1988. 77p. (MICROLOG–90-02179). Available from PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Air leakage represents a substantial part of the heating and cooling load of most large buildings and can also be an important parameter of indoor-outdoor pollution relationships by allowing untreated air to penetrate the building. Heat loss associated with envelope air leakage of typical office buildings can be as much as 40% of the total heat load in most Canadian climates. Public Works Canada studies into air leakage characteristics of buildings are part of the development of the total building performance concept and are a response to the need for accurate energy consumption analysis of existing buildings. This document outlines the methods employed to determine airtightness characteristics and infiltration rates at different pressure differentials. The first method used is that of calibrated fans to either pressurize or depressurize a building to determine the airtightness characteristics at various pressure differentials. In the case of a very large building, the tracer gas decay rate method is used to determine infiltration rates at various mechanical system operating settings and resulting pressure differences. 11 refs., 1 fig.

30537 (PWC/AES–1-4:86-46) **Measurement of outdoor air supply rate.** Building performance evaluation series, Document D37. Public Works Canada, Ottawa, ON (Canada). Architectural and Engineering Services. Mar 1988. 93p. (MICROLOG–90-02178). Available from PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This document presents a method for using tracer gases to evaluate the effectiveness of ventilation systems in supplying outdoor air. The techniques presented are intended for use in large multistorey office buildings but can be adapted for use in other types of buildings. A number of factors have led to increased concern about air quality in buildings, including improved airtightness of building envelopes, reductions in the amount of outdoor air supply in the interest of energy conservation, new approaches to ventilation system design, and increased use of synthetic materials in the building fabric and in furnishings. The methods outlined measure the rate at which a ventilation system supplies outdoor air. The results can be input as specific parameters in energy analysis models to estimate how outside air introduced by the ventilation system affects the total energy consumption of the building and whether these figures are acceptable. These data, along with findings from other tests are used to determine if modifications to the system are required and if the building meets current Public Works Canada standards. 12 refs., 12 figs., 1 tab.

30538 (SEMR–FP28) **Flax straw burner: Final technical report.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 63p. (CE–02947). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Flax straw is a an example of a waste material that cannot easily be recycled into the soil as a fertilizer or used as a cattle feed. Normally, flax straw is burned in the field and the residue is plowed into the soil. The objectives of the project were: to design and build a centrally-located flax straw heating system on a farm; to demonstrate the system to other farmers and interested people; to evaluate the ability of the system to heat a farm house and a large workshop; to monitor the energy consumption and detailed performance of the system; to assess the practicality of this type of system for general application on farms in Saskatchewan. This report is concerned with the technical and economic aspects. The flax straw heating system appeared to be a good alternative for those farmers who have access to flax straw and are considering off-oil conversion. The system is relatively trouble-free and the economics are favourable. The only drawback is the low efficiency of the unit (25%). While this is tolerable in terms of fuel consumption,

it does involve a lot of unnecessary re-charging, which can become inconvenient. In future designs it would be advisable to increase the system efficiency by incorporating a secondary combustion system. 6 figs., 13 tabs.

30539 (SEMR–FP34) **Earth-sheltered residence: Final technical report.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 47p. (CE–02936). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report consists of a detailed assessment of the design and construction of an earth-sheltered house at Keeler, Saskatchewan. The earth-sheltered concept is the outstanding feature of this house, but the ultimate performance of the house will be determined by the other features of the construction and the owner's willingness to incorporate the recommended changes. In this respect, the most important factors relate to the insulation of existing thermal bridging paths, the elimination of the crawl space as a warm air plenum, and the installation of air management systems along the lines recommended. Since the house is not yet completed, and since its final design details are still not certain, it was impossible to quantify its energy-efficient performance. There are indications that the house is already highly energy-efficient, even in its present stage of construction. However, this level will probably decrease once the house is fully operating with ventilation air and combustion air supply. The recommended changes will help the owner to maintain a high level of thermal efficiency, and will ensure that the house is safe for living in. Full cost records have not been kept, and the owner has obtained many services and materials at low costs. Accordingly, it was not possible to conduct a simple economic analysis on this house. 4 refs., 8 figs.

30540 (SRC–FP15) **The Prince Albert Conservahome: Final technical report.** Saskatchewan Research Council, Saskatoon, SK (Canada). [1984]. 48p. (CE–02944). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The city of Prince Albert is located centrally in Saskatchewan, close to the northern edge of the prairie. It is the largest population centre in Saskatchewan, at this latitude, and was chosen for its demonstrational potential. This report gives details of the retrofit and rehabilitation work conducted on a house in Prince Albert, Saskatchewan, as part of the Conservahome project. This project involved the retrofit and rehabilitation of six houses of various ages and styles, and was funded by CREDA, the federal-provincial Conservation and Renewable Energy Demonstration Agreement. In selecting the Prince Albert Conservahome, attention was focused on post-1960 houses that would lend themselves to high-level retrofit. Retrofit work detailed in this report included work done in the basement, the exterior walls, the attic, the doors and windows, and the gas furnance. 16 figs.

30541 (SRC–FP16) **The Moose Jaw Conservahome: Final technical report.** Saskatchewan Research Council, Saskatoon, SK (Canada). [1984]. 28p. (CE–02937). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The city of Moose Jaw is located in south-central Saskatchewan. It was chosen for the Conservahome Project on the basis of its fairly large population, which would add to the demonstrational value of the project. This report gives details of the retrofit and rehabilitation work conducted on a house in Moose Jaw, Saskatchewan, as part of the Conservahome project. This project involved the retrofit and rehabilitation of six houses of various ages and styles, and was funded by CREDA, the federal-provincial Conservation and Renewable Energy Demonstration Agreement. The selected house was built in 1976 in a new residential area. The front of the house faces north on an east-west street. The rear of the house has good solar access across an un-landscaped backyard. The Caribou Heights Addition is a quiet residential area on relatively high ground in the north-west area of Moose Jaw. The water table was judged to be low and the soil type was not conductive to basement problems. The Moose Jaw Conservahome is of interest as an exercise in low-level retrofit in which the majority of costs could be covered by exisiting government funding programs. With such cost constraints the retrofit options are somewhat restricted, and on this house consisted of sealing techniques and moderate upgrading of insulation levels in the attic and basement. 14 figs.

30542 (SRC–FP18) **The Yorkton Conservahome: Final technical report.** Saskatchewan Research Council, Saskatoon, SK (Canada). [1984]. 48p. (CE–02946). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The city of Yorkton is located in south east Saskatchewan close to the Manitoba border. It was chosen for the Conservahome Project on the basis of its fairly large population and its geographic location - both of which would add to the demonstrational value of the project. This report gives details of the retrofit and rehabilitation work conducted on a house in Yorkton, Saskatchewan, as part of the Conservahome project. This project involved the retrofit and rehabilitation of six houses of various ages and styles, and was funded by CREDA, the federal-provincial Conservation and Renewable Energy Demonstration Agreement. The front of the house faces west on a north-south street. The house was built in 1963. Plans were not filed with the city building authorities, but it was discovered that the house design was a standard design that was still on file with the builder. The Yorkton Conservahome is of interest for the following reasons: the basement walls were insulated by two different techniques, one involving a wood-frame construction and the other involving the application of a rigid insulation system; retrofit of the exterior house walls was limited to the sealing of air leakage points; and several different techniques were tried for upgrading the thermal performance of the windows. 14 figs.

30543 (SRC–FP19) **The Mardstone Conservahome: Final technical report.** Saskatchewan Research Council, Saskatoon, SK (Canada). [1984]. 53p. (CE–02945). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report gives details of the retrofit work conducted on a house in Maidstone in Saskatchewan, as part of the Conservahome Project. The Project involved the retrofit and rehabilitation of six houses of various ages and styles, and was funded by CREDA: the federal-provincial Conservation and Renewable Energy Demonstration Agreement. Maidstone is a small town located on the edge of the heavy crude oil deposits in north-western Saskatchewan. There were three main reasons for choosing this town as a site for one of the Conservahomes. It presented an opportunity to include an oil-heated house in the project, all other locations being predominately gas-heated. It presented an opportunity to investigate the particular problems of retrofit in an essentially rural situation. Retrofitting work was done on the basement, the attic, the doors and windows, the verandah and porch and the domestic hot water heater. 15 figs.

30544 (TNO-TPD–613.006) **An energy registration and management plan by means of a building management system in the hospital 'Sint Franciscus Gasthuis' in Rotterdam, Netherlands.** Nicolaas, H.J.; Peitsman, H.C. Nijverheidsorganisatie TNO, Delft (Netherlands). Technisch Physische Dienst. Apr 1988. 106p. (In Dutch). Project PEO 11.32-102.40. Order Number DE90767893. Available from NTIS (US Sales Only), PC A06/MF A01.

To realize the title plan, first the necessary data were collected on the buildings and their installations, the organization of the building management system, control systems and the already present measuring sensors. Then the electricity and natural gas consumption figures were analyzed. The electricity consumption was subdivided into five levels: monthly consumption, monthly consumption per transformer, daily and hourly consumption per transformer, hourly consumption of terminal groups and hourly consumption per appliance (ventilators, elevators, pumps, etc.). The gas consumption is determined for the central hot water boilers and the combustion furnace. A method to specify the building

thermally is presented by means of monthly, daily and hourly consumption figures. An indication is given to gain insight into the cooling and heating enthalpy hours based on the building management system. Examples are given with which energy conservation measures can be evaluated and compared to the results of the energy registration system. 27 figs., 2 refs., 22 tabs., 3 apps.

30545 (VTT-TIED–1061) **Field study of buildings thermal insulation in earth contact.** Flygare, P. (Valtion Teknillinen Tutkimuskeskus, Oulu (Finland). Rakennuslaboratorio); Kivikoski, H.; Niskala, E. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 206p. (In Finnish). Order Number DE90770757. Available from NTIS (US Sales Only), PC A10/MF A01.

A field survey was made of frost and heat insulation in buildings constructed in 1976-1985. The materials used were expanded polystyrene, cellular polyurethene, mineral wool and expanded clay. The properties of these materials were studied by means of laboratory measurements performed on samples collected in the field, in addition to which field measurements were carried out over a period of about a year to assess how well the insulation functioned in practice. All the materials studied absorbed water if exposed to moisture for long periods, e.g. to groundwater, capillary soil water or surface water, the highest moisture content values being recorded in insulation layers which were reached by the groundwater table from time to time. Similarly insulation slabs located beneath downpipes or leaking gutterings were markedly damper than others nearby. These effects could be reduced by constructing suitably wide eaves or providing water-retaining protective covering over the insulation layer. Compression of the polystyrene sheets usually amounted to less than 10% of their nominal thickness, but could be greater at more heavily loaded points. The compression of mineral wool slabs was normally less than 14%, but was greater when the material was damp, whereas no obvious correlation existed between moisture content and compression in the case of polystyrene sheets. The increase in heat conductivity (λ_{10}) compared with new material was usually less than 50% in the case of polystyrene but over 50% in that of mineral wool. Typical forms of damage incurred by insulation sheets in the ground were twisting, cracking and points of high local compression, all these being due to irregularities in the foundation on which the sheets were laid, poor compaction, the presence of large stones or the use of building rubble in the filtration layer or in the filler inserted immediately above the insulation.

30546 (YEDT–3766-4-3) **Residential greenhouse: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Feb 1985. 42p. (CE–02915). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $0.34 CAN per page, $3.40 minimum; MF $10 CAN.

The following report examines the technical and economic viability of residential greenhouse additions in Whitehorse, Yukon. The greenhouse was constructed using the south facing wall of an existing residence as a common wall. Total construction costs were $18,000, including labour. Annual fuel demand for the residence has been reduced by about 10 per cent for an annual saving of $425. In addition, produce to the value of $1,000 is grown annually in the greenhouse for domestic consumption and commercial resale. Typically the greenhouse operates for nine months each year. There is a net thermal loss during the months of November, December and January as a result of the large area of glazing. As well as supplementing the heating supply solar greenhouses can provide additional cash crops which can be used to offset the cost of construction. Humidity problems are minimal and can be dealt with by exhausting high humidity air. One system which has been considered for the greenhouse is to use a standard residential heat pump to remove excess moisture and to pump heat into the house. This would have a secondary benefit of excluding the need to circulate greenhouse air through the house. Thus any allergenic reactions to the greenhouse air would be prevented. 8 refs., 3 figs, 2 tabs.

30547 (YEDT–3766-4-9) **New home construction: Eric Allen: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Feb 1987. 40p. (CE–02916). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report describes some special energy efficient measures incorporated in the construction of a modestly-priced two and a half storey frame house with a floor area of 108 m^2. The house was built facing south, on a south-sloping lot with a thick stand of Jack Pine on the north side. The major energy efficient measures are: continuous air-vapour barrier and high insulation level to make the house as air-tight as possible; the use of passive solar heat which is expected to supply 37% of the annual heating requirements; a crawlspace plenum which draws hot air from the top of the house and recirculates it under the first floor; and use of horizontal strapping on which all wall partitions, electrical and plumbing work was done in order not to break the continuous air-vapour barrier and which itself provides extra insulation. The cost of making the house energy efficient was $2,500. The price of the house on completion was projected to be $65,000. The cost for the energy efficiency measures is 4% of the total. The Allen house is a good example of how an investment of a small percentage of the total cost, and about 67 hours of work, can result in an energy efficient house. The resulting savings on energy bills can be quite significant and can mean a return on the investment within 5 years. 3 figs., 1 tab.

30548 (YEDT–3766-4-16) **Public building retrofit: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Jan 1982. 36p. (CE–02917). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report demonstrates the economic viability of cost effective, energy efficient retrofitting of a public building. The Whitehorse Chamber of Commerce in conjunction with the Canada/Yukon Conservation and Renewable Energy Demonstration Project undertook the demonstration project. The energy conservation features included increasing the insulation in the walls and ceiling, providing a 6 mm polyethylene air-vapour barrier and installing triple glazed windows on the north side. Also, an air-to-air heat exchanger and a combination wood/oil furnace were installed. However, neither of these latter features have been used since the completion of the renovations. In total, the features cost approximately $26,300. The energy conservation measures yielded less energy savings than expected. Although the T.C. Richard building is now consuming less heating oil (33% less); the amount of electricity used has increased by 146.6%. Overall the building achieved a 23% reduction in heating consumption (this figure takes into account the heat energy generated from the lighting system). Reasons for the low yield in energy savings can be attributed to the improper installation of the air-vapour barrier and not using the existing wood boiler. 1 fig. 5 tabs.

30549 (YEDT–3766-4-22) **Guild Hall retrofit: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Aug 1984. 58p. (CE–02921). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report demonstrates the economic viability of an exterior rewrap retrofit performed on a public community facility for the performing arts. This facility originally consisted of two mess halls built by the American army. The exterior retrofit consisted of constructing a super-insulated passageway to link the two halls as well as completely wrapping the facility with six millimetre polyethylene to provide an airtight barrier. The roofs and walls were reinsulated and insulation levels were increased to RSI 10.5 in the ceilings and RSI 7.7 in the walls. The installation of a propane fuelled furnace was also included in the retrofit package. Prior to the renovations and retrofitting, the Guild Hall facility was almost unusable. The demonstration project transformed the cold, drafty buildings into an attractive, comfortable and functional centre for the performing arts. Heating requirements have been reduced to 500 MJ/m^2 of floor

space annually compared to a predicted 1,760 MJ/m^2 of floor space based on HOTCAN analysis of the heating requirements without the energy conservation measures. 9 figs., 10 tabs.

30550 (YEDT–3766-4-27) **Skookum Jim Friendship Centre retrofit training: Final project summary.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). Aug 1984. 45p. (CE–02919). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The retrofit/renovation of the Skookum Jim Friendship Centre in Whitehorse, Yukon, provided an ideal opportunity to train ten carpenters as specialists in energy conserving construction at the community level throughout the Yukon. Through this project, the trainees have gained special skills through hands-on experience with many energy conserving materials and techniques. As well, the training sessions provided extensive information on applicable thermodynamic principles and building science technology. The crew of two instructors, ten trainees, and the foreman covered all aspects of residential/light commercial construction which apply to retrofit work. Training sessions included information on site-safety, and interpreting the National Building Code, as well as special attention to the air tightness and insulation levels in the building. In observing the operation of the new building during the first heating season, it was noted that the heat provided by the lighting in the building supplied the majority of space heating requirements. Back-up electrical heating was required only at temperatures approaching design temperature for the building. 6 Figs.

30551 (YEDT–CE02912, pp. 44-58) **Building standards for northern Canada.** Bushey, R. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper outlines building standards for energy-efficient homes in northern Canada. Over the last year a residential standard has been developed to encourage the construction of energy efficient housing in those areas of Canada north of the southern limit of discontinuous permafrost. This standard has been applied for the 1984 construction season for new residential construction. The objectives of the standard are to promote energy efficient building designs, equipment and building practices that are suitable to northern lifestyles and the unique climatic conditions found in the various northern areas. The project is concerned with incorporating the experience of northern builders in Canada and from other countries in constructing stable foundations on discontinuous and continuous permafrost soils, airtight building envelopes, suitable heating and mechanical ventilation systems and implementing energy conservation technologies that have been developed in recent years. 1 tab.

30552 (YEDT–CE02912, pp. 62-74) **Log versus frame housing.** Carlson, A.R. (Univ. of Alaska, Fairbanks, AK (USA)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The need for conservation of energy necessitates a more careful look at the thermal properties of building materials. Unfortunately, the failure to review existing information on thermal properties of wood has resulted in the underrating of the insulation values of a log house. Also, the failure to include the framing members in the thermal analysis of a frame wall has resulted in the overrating of the insulation value of a frame house. In order to compare thermal value of a log house against a stud frame house, a complete heat loss analysis should be conducted to determine the effect of the heat loss of all exposed surfaces. It is recommended that the average insulation of all exposed floor, wall and roof surfaces be taken into account, rather that attempting to evaluate insulation values of a house based on a single surface such as the wall. Deficiencies in thermal properties of walls can be made up by installing thicker insulation in the roof with little extra cost. The effective insulation value of a wall can be increased substantially by more judicious sizing and placement of windows. Solar gain through glass can be improved by maximum use of south-facing windows. To avoid extra studs in a wall due to windows and doors, it is strongly recommended that the designer draw an elevation of each wall to develop the most efficient use of labor, materials and energy. 6 refs., 10 tabs.

30553 (YEDT–CE02912, pp. 78-94) **Feasibility of large log buildings for the Mackenzie Valley: An interdisciplinary study with the government of the N.W.T.** Lee Tang (Faculty of Environmental Design, Univ. of Calgary, Calgary, AB (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Department of Public Works, Government of the Northwest Territories wished to learn more about using log structures for some of their buildings. A proposed school and community hall in Snowdrift was used as a model for testing the feasibility of this concept. The Architectural division of the Dept. of Public Works was to lead the study. A team of participating specialists from private industry, ranging in expertise from forestry to building science provided detailed inmput to the study. In addition, over 40 people from across Canada and the United States, including native groups, were also consulted. The result of the effort is a technical report and a set of recommendations to the Government of the N.W.T. It can be argued that the single wythe log wall is inappropriate for use in the far north because it lacked sufficient insulating value. It can also be argued that log structures are inappropriate for any place where there is a heating load. The decision to use log construction for the walls of the Snowdrift School and Community Hall is less dependent on its thermal properties, but on other matters such as the sociological aspects. 21 refs., 4 figs., 3 tabs.

30554 (YEDT–CE02912, pp. 106-115) **Retrofitting government buildings in the Northwest Territories.** Burdett-Moulton, H. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Canadian Eastern Arctic has problems that affect its construction industry. It is plagued with expensive transportation, expensive energy and a short building season. Often the most economically viable solution to the regional building plan is to retrofit existing buildings. Projects for retrofitting are identified by an extensive building audit, a thermography scan and an evaluation of the energy consumption figures. Exterior retrofits are the most effective way to rehabilitate a building for energy conservation. In remote communities fiberglass insulation and wood framing are the simplest means of construction. In more populous centres a sprayed urethane system has distinct advantages. Retrofits in the Baffin Region have shown an economic payback of approximately 10 years and are saving 2/3 of the fuel cost. Fuel alternatives to oil are lacking in the Eastern Territories. Energy conservation is the only thing that can reduce dependency on oil. Retrofitting is a means of fuel conservation and a viable alternative to new construction which costs approximately $1,400. per m^2 as compared to $495. per m^2 for retrofitting. The paybacks on retrofits average 10 years which is less than 1/2 the expected life of the building. Approximately 2/3 of the fuel consumed by the building is saved. 8 refs., 1 fig., 2 tabs.

30555 (YEDT–CE02912, pp. 189-202) **Retrofit options for private dwellings.** Olney, J. (Univ. of Alaska, Fairbanks, AK (USA)); Seifert, R.D. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The older buildings of Alaska, especially those more than ten years old, often have poor insulation and inadequate protection from vapor and moisture problems. This review of retrofit options first addresses what happens to moisture transport and vapor pressures in the wall when insulation is added. Temperature gradients and allowable relative humidities (to limit moisture condensation) are presented in tabular form. These tables are prescriptive tools and can be used to show where moisture problems will occur if water vapor gets to different sections of the wall due to vapor barrier holes or failures. A review of several retrofit projects from the Fairbanks, Alaska area is included. Fairbanks, with an approximately 14,500 °F-day (8,000 °C-day) heating index, and a design temperature of -47°F (97.50 percentile) provided a natural laboratory. It also has a housing stock with a wide range of ages. Energy costs are high in Fairbanks. An additional incentive to retrofit older houses is a continuing energy audit program funded by the state. This program loans money at an interest rate of 5% for energy conserving improvements which are recommended in the audit program, and which have a ten year or less payback period. 11 refs., 3 figs., 2 tabs.

30556 Thermal characterization based on high time resolution end-use metered data. Pearson, E.W. (Pacific Northwest Lab. (USA)); Miller, N.E.; Stokes, G.M. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249–: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

High time resolution electrical end-use data, along with supporting weather and characteristics information, is becoming available from several major metering projects. The authors have developed a general approach to characterization of residential thermal performance based on such data. They begin by deriving a nonparametric relationship between space heating requirements and inside-outside temperature difference from data aggregated to the daily level. The statistical method used is resistance to outliers. Data that is contaminated by wood heat use, or is not reflective or normal occupancy patterns are excluded prior to the fitting process. The resulting model can be used with a reference set of temperature data to derive a standardized measure of annual space heating load. Through analysis of the residuals from the model, they investigate the role of factors other than temperature in determining space heating requirements. In this paper the authors present our approach, and illustrate it with examples drawn from the Bonneville Power Administration's End-Use Load and Consumer Assessment Program (ELCAP).

30557 Outdoor-Indoor temperature relationships. Nordman, B. (Lawrence Berkeley Lab., CA (USA)); Meier, A. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249–: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The authors investigated the relationship between outside and inside temper- atures for several hundred houses in the Pacific Northwest. While the analysis was initially adopted as an efficient means of detecting faulty data, it also revealed unusual patterns of inside temperatures. These patterns included large fluctuations in weekly average inside temperature and a drop in inside temperature corresponding to drops in the outside temperature. The inside temperature pattern for most houses appeared to fall into two regions. At low temperatures, the thermostat settings dominated the behavior but at warmer outside temperatures, the float dominated the inside temperature. In order to determine if the observed patterns were due to simple thermostat management, the authors performed computer simulations of similar houses to generate synthetic inside temperatures. These simulations demonstrate that observed outside-inside temperature patterns could be explained by thermostat setbacks and floating. The results are found to improve understanding of thermostat behavior and permit more realistic estimates of heating energy use for houses operated with thermostat setbacks.

30558 The incremental value of monitored building energy data. Meier, A. (Lawrence Berkeley Lab., CA (USA)); Nordman, B. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249–: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

They present an energy conservation program in this paper and focus on the value, in terms of economics and accuracy, of different means of data collection and analysis.

30559 Statistics and simulations: An integrated approach to studying the office building sector. . Crawley, D.B. (Battelle Pacific Northwest Lab., Richland, WA (USA)); Briggs, R.S.; Brodrick, J.R. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249–: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

With the advent in recent years of building energy simulation models and end-use metering capabilities, increasingly reliable and detailed information has become available on the energy use of specific buildings. To study the potential impact of and markets for new equipment, information is needed on the energy requirements of entire segments of the building population, not just on individual buildings. A need has existed for detailed energy use profiles and end-use breakouts that can be confidently applied to major building segments as a whole. This paper documents a new methodology used to categorize the office sector, describes the resulting categories, and discusses the limitations encountered in using the method with available data sources. The approach uses a data base of the nation's office buildings, a statistical technique known as cluster analysis, and energy modeling, to define building categories. The paper also describes the process used to develop representative building descriptions that can be used as input to the DOE-2 energy simulation program. An example study is provided.

30560 Adjustment of residential heating loads predicted by degree day models across climate zones in the Pacific Northwest. Conner, C.C. (Pacific Northwest Lab. (USA)); Lucas, R.G. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). DOE Contract AC06-76RL01830. (CONF-8808249–: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

Heating-degree-day-based prediction models such as PRISM are a simple and common method of calculating heating loads for residential buildings. Implicitly assumed in these models is that the UA and temperature are the only driving variables. However, climate variables such as solar gains and daily temperature swing also have an effect on heating loads. These variables will not be correctly accounted for when predicted heating loads for one climate are based on measured data for a different climate if only heating degree days are used. This paper examines the correlation of outdoor temperature with various climate variables. Synthetic data produced from the SUNCODE simulation model have been used for this analysis. Four Northwest locations have been studied and simulated to cover a wide range of building UAs and solar gains. A systematic bias is demonstrated in the correlation of temperature with solar gains. Results indicate that heating- degree-day-based methods using data from milder climates overpredict more severe climates, and conversely, the colder climates underpredict the milder climates. Significantly more accurate predictions are obtained when climate parameters in addition to the heating degree days are accounted for.

30561 An algorithm to disaggregate commercial whole-building hourly electrical load into end uses. Akbari, H.

(Lawrence Berkeley Lab., CA (USA)); Heinemeier, K.E.; Le Coniac, P.; Flora, D.L. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249--: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The authors analyzed whole-building electric-load data taken at 15 minute intervals for selected commercial buildings in southern California and have identified major characteristics of the loads. The information obtained from this analysis has been used to develop an end-use disaggregation algorithm (EDA) to break down total building load into major end uses. Hourly load data, hourly load-temperature regression coefficients and simulation end-use results comprise the algorithm input. The EDA produces hourly load profiles for air conditioning, lighting, fans and pumps, and miscellaneous loads. The hourly profiles are then averaged to produce typical end-use profiles for each building. The EDA algorithm has been applied to seven buildings, and hourly end-use profiles have been extracted; the results of the analysis of two of these buildings are presented in this paper. These profiles are compared with those generated by simulation and simple proration techniques.

30562 Patterns of electric water heater use and the effects of water heater load control on customers. Reed, J.H. (Oak Ridge National Lab., TN (USA)); Broadwater, R.P.; Chandrasekaran, A.; Thompson, J. vp. of Behavior and lifestyle. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808250--: Behavior and lifestyle, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper reports on the analysis of water heater load control experiments conducted as part of the Athens Automation and Control Experiment (AACE). The analysis is based on data from end-use monitoring devices as well as survey data. A total of 36 water heaters were monitored during the winter months of 1986/87. Water heaters were turned off for periods of 2, 3, and 4 hours during the morning and evening peaks. The analysis of hot water consumption showed that 80% of the customers would have sufficient hot water for an entire day if they had 120 gallon water heaters. This suggests that storage water heating might be a viable alternative to direct control of water heaters.

30563 The third variable in daily household energy consumption. Bernard, M.J. (Q4 Assoc. (US)); Collins, N.E.; McBride, J.; Desmond, D.J. vp. of Behavior and lifestyle. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808250--: Behavior and lifestyle, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The daily energy consumption for a household during the heating season may be segmented into three components. The structural energy is that consumed if no one lived in the home heated to the thermostat settings. The habitual or routine energy consumption captures the ordinary, periodic (daily or weekly) activities of the residents, the static characteristics of the family (e.g., work and school schedules, cooking habits, and washing and drying clothes every Saturday), and the typical number of people in the household. The dailyvariation in energy consumption is a function of unusual and unpredictable household events such as parties, holidays, vacations, sick children, and broken windows. The last variable is the focus of this paper.

30564 The effects of model simplifications on equivalent thermal parameters calculated from hourly building performance data. Taylor, Z.T. (Pacific Northwest Lab. (US)); Pratt, R.G. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249--: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

Using high resolution metered data of building heating performance and environmental conditions, equivalent thermal parameters (ETPs) can be identified for a building. These parameters, which typically include an effective envelope conductance, an effective thermal capacitance, and effective solar apertures, can be extracted via several methods that have been developed and demonstrated in other studies. If regressed ETPs are physically meaningful, they can be adjusted to account for potential retrofits, and energy performance under different conditions can be estimated. This paper evaluates the ability of one multiple regression technique to identify physically meaningful parameters and to predict performance. Using computer simulations to generate pseudo data and eliminate uncontrolled variables, this paper reports the effects of driving forces not explicitly included in the model on the derived ETPs. Specifically, ETPs are regressed for a simple, massless house with no solar or internal gains. The house is then modified to include various combinations of solar gains, internal gains, envelope mass, and ground coupling. ETPs are calculated for each scenario. The derived ETPs are then used to estimate consumption for comparison with the original simulations.

30565 Performance of cooling-only and heating-only prism models in extreme climates. Rufo, M.W. (XENERGY, Inc. (US)); Brambley, M.R. vp. of Performance measurement and analysis. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808249--: Performance measurement and analysis, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

Recently, there has been increased interest in analyzing the usefulness of the Princeton scorekeeping method (PRISM) for monitoring consumption in all climates and building types across fuels. Two unique climate applications of PRISM are presented in this paper. In the first application, the cooling-only PRISM model is used to analyze the electricity consumption of 166 electrically-cooled, gas-heated residences in the hot, humid summer climate of St. Louis, Missouri. In the second application, the authors use the heating-only PRISM model to analyze the natural-gas consumption of 110 gas-heated residences in the very mild heating climate of San Diego, California. The overall model fit in both applications is reasonably good, but is somewhat poorer than is typically found for gas-heated residences in cold climates. In both cases, the PRISM parameters most poorly estimated are the heating and cooling slopes. In general, the results from the two applications are more similar to each other than to results obtained form applications of PRISM to gas-heated residences in cold climates.

30566 Conservation retrofits in institutional buildings: Summary and comparison of ninety projects in Oregon. . Ingram, A.E. (Bonneville Power Administration (US)). vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

In Oregon, ninety buildings were retrofitted under the Institutional Buildings Program. Bonneville budgeted $5.3 million for incentives and retrofit administration. Buildings retrofitted included dormitories, office buildings, gymnasiums, swimming pools and repair shops. Measures installed included: energy management systems, lighting reductions and retrofits, insulation of walls and ceilings, heating ventilating and air conditioning equipment changes and additional miscellaneous conservation efforts. All of these projects were visited and/or reviewed by the author from February 1987 through July 1988. During the reviews, information regarding program implementation was collected. This information included energy savings estimates, measure cost, administrative cost, measures installed, changes in project scope and operation of individual retrofits. This report summarizes the operating experience gained from a 5 year, $5.3 million conservation retrofit program targeted at institutional buildings.

30567 The Critical Needs Weatherization Research Project. McBride, J.R. (National Center for Appropriate Technology, Butte, MT (USA)); Castelli, B.T.; Desmond, D.J.; Kelly, M.P. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The Commonwealth of Pennsylvania developed the Critical Needs Weatherization Research Project as an alternative to current weatherization and fuel bill assistance programs. The project tested the combined effectiveness of zone heating, infiltration reduction measures, and participant education in substantially reducing home heating costs. A microprocessor based remote data acquisition system was installed in the homes of the 25 participating low-income, payment troubled natural gas customers (15 in

Pittsburgh, 10 in Philadelphia) to collect hourly end-use natural gas consumption and thermal data. Entry and exit interviews and a participant household activities reporting scheme were used to collect participant observations.

30568 Energy conservation potential: A review of eight studies. . Pirkey, D.B. (U.S.Dept. of Energy (USA)); Scheer, R.M. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper discusses a review of eight studies on energy conservation potential and a subsequent workshop at which authors of some of the studies presented their viewpoints on the topic. What conservation potential has been achieved and what can still be achieved are issues that have been recently discussed in light of concerns about national energy security. For historical perspective and insight, the review addressed this topic. While the studies differ in purpose, methodology, and projection period, they are similar in that each contains an estimate of energy conservation potential. When the review was completed, a workshop was held to provide the authors with an opportunity to express their opinions on how their work was characterized in the review. The discussion described in this paper included ideas about the purpose, need and types of future studies on energy conservation potential.

30569 The experience of energy conservation programs with new commercial buildings. Vine, E. (Lawrence Berkeley Lab., CA (USA)); Harris, J. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

As part of Lawrence Berkeley Laboratory's Least-Cost Utility Planning Project, the authors have recently completed a review and assessment of the experience of 30 energy conservation programs with new commercial buildings in the U.S. and other countries. The focus was on non-mandatory strategies, which complement, reinforce, or in some cases may substitute for energy-efficiency requirements in building codes. The programs are primarily conducted by state and federal agencies and utility companies. The types of programs investigated include: large-scale demonstrations, financial incentives, energy rating and labeling, energy awards, design tools, design assistance, and standards-related training, compliance and quality control programs. In this paper, the authors focus on design assistance programs and examine available data on market penetration, energy and cost savings, program costs, and cost-effectiveness. Despite the scarcity of quantitative evaluation data on most programs, they present their major findings and make recommendations for program managers interested in designing and implementing energy conservation programs for new commercial buildings.

30570 Program design and success: A review of two utility lighting programs. . Gandhi, S. (Lawrence Berkeley Lab., CA (USA)); Krause, F. vp. of Utility and private sector conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808245--: Utility and private sector conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

While many utilities in the U.S. have planned and operated demand-side management programs, there has been very little effort to gather, evaluate, and apply the program experience and insights gained to the planning of future programs. The work described in this paper is part of a research effort to improve the understanding of both demand-side technologies and programs. In this paper two illustrative examples are analyzed, a residential and a commercial lighting program. The features of these programs were investigated in detail, including aspects of program design, the range products and services, information outreach to customers, involvement of trade allies, rebate mechanism, rebate level and its impact on customer's first cost, as well as characteristics of participants, participation rate, program costs and savings. Interviews with program managers responsible for these programs provided further supplementary information. This information was used to determine the effectiveness of the programs and it acceptance by customers.

30571 Blue Clue: Appliance dealer participation. . Vincent, G.W. (Bonneville Power Administration (US)). vp. of Utility and private sector conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808245--: Utility and private sector conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

There is increasing concern that it may not be cost-effective to offer rebates to consumers for the purchase of energy-efficient refrigerators. There is also increasing agreement that appliance dealer participation and support are critical for program success, whether or not a rebate is offered Bonneville Power Administration (BPA) has been running its Blue Clue program in the Pacific Northwest since September 1986. The purpose of the program is to make it easier for purchasers to identify the most energy-efficient refrigerators and freezers on the market. No rebates are offered, and there is a strong emphasis on dealer participation. This summary report presents BPA's experiences with respect to dealer participation in the Blue Clue program. Included are discussions of dealer attitudes and behaviors, lessons learned, and future program directions.

30572 A survey of the use of infrared thermography in the Department of Energy's Weatherization Assistance Program. Snell, J.R. Jr. (John Snell and Associates, Montpelier, VT (USA)). pp. 206 of Proceedings of an international conference on thermal infrared sensing for diagnostics and control. Thermosense XI. McIntosh, G.B. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8903155--: 11. thermosense: thermal infrared sensing for diagnostics and control, Orlando, FL (USA), 29-31 Mar 1989).

The Low Income Weatherization Assistance Program (W. A. P.) provides weatherization service to low income home owners and tenants throughout the United States to help them reduce domestic energy consumption. During the early years of the program infrared thermography played a small but vital role, primarily as a research and development tool. In the past four years, however, programs in nearly 50% of the states have invested in over 75 units of thermographic equipment and training. This interest in thermography has been prompted by the dual needs of monitoring current work and improving future work through increased training. Although little hard data exists to document the return on this recent investment, this survey of weatherization programs around the country indicates that programs with strong administrative support which also invested in both appropriate equipment and on-going user training are making substantial and cost effective improvements in their programs. It appears thermography will continue to make strong and increasingly greater contributions to improving the quality of the weatherization program in the years to come.

30573 The impact of summer heat islands on cooling energy consumption and CO_2 emissions. Akbari, H. (Lawrence Berkeley Lab., CA (USA). Applied Science Div.); Huang, J.; Martien, P.; Rainer, L.; Rosenfeld, A.; Taha, H. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

It has been documented that summer heat islands increase the demand for air conditioning. Several studies have suggested developing guidelines to mitigate this negative effect, on both micro-and meso-scales. Reducing summer heat islands saves cooling energy, reduces peak demand and reduces the emission CO_2 from electric power plants. This paper summarizes efforts to quantify the effects of techniques to reduce heat islands. In particular the authors summarize simulations made on the effects of planting trees and switching to light colored surfaces in cities. Their results indicate that these techniques effectively reduce building cooling loads and peak power in selected U.S. cities, and are the cheapest way to save energy and reduce CO_2 emissions. This paper compares the economics of technologies to mitigate summer heat island with other types of conservation measures. The authors estimate the cost of energy conserved by planting trees and recoating surfaces

on a national level and compare it with the cost of energy conserved by increasing efficiencies in electrical appliances and cars. Early results indicate that the cost of energy saved by controlling heat islands is less the 1c/kWH, more attractive than efficient electric appliances (-2c/kWH), and far more attractive than new electric supplies (-10c/kWH).

30574 **Evaluation of DOE's partners in Low-Income Residential Retrofit Program: Summary Paper. .** Callaway, J.W. (Pacific Northwest Lab. (US)); Lee, A.D. vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244--: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

In July, 1986, the U.S. Department of Energy awarded competitive grants of $100,000 each to five states to develop and implement innovative leveraging programs to test the feasibility of public-private partnerships to accomplish low income residential energy retrofits. These programs have been tracked and analyzed through a concurrent process evaluation conducted by the Pacific Northwest Laboratory. The results of this analysis are presented. Each of the five states (Florida, Kentucky, Iowa, Oklahoma and Washington) has utilized a different approach to increase the amount of private and nonprofit sector involvement in support of weatherization of low income dwellings. These pilot programs are designed as supplements, rather than replacements of the existing major federal grant programs (the Weatherization Assistance Program and the Low Income Heating Energy Assistance Program).

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Refer also to citation(s) 29957, 30996, 31348, 31746

30575 (AD-A-217462/1/XAB) **CRC (Coordinating Research Council) octane number requirement rating workshop. Held in d'Hanis, Texas on April 10-14, 1989.** Coordinating Research Council, Inc., Atlanta, GA (USA). Oct 1989. 39p. (CRC-567). Available from NTIS, PC A03/MF A01.

The main objective of the workshop was to improve the application of the CRC E-15 Technique for Determination of Octane Number Requirements of Light-Duty Vehicles among people familiar with the Technique so as to provide consistent results for vehicles equipped with modern automotive technology. This objective was pursued for both the set-up portion of the technique and the actual octane rating of the vehicle. An additional objective was to gather comments from the raters on the E-15 Technique as preparation for a proposed rewrite of the Technique. Since the workshop was to be an educational experience rather than a source of octane requirement data, emphasis was placed upon exchange of information as opposed to data collection and analysis. The intent of the workshop was not to rate the raters, but to reduce the laboratory-to-laboratory variations in the application of the E-15 Technique. Thirteen 1989 model vehicles were available for track testing. As indicated below, Five of the vehicles were set-up with auxiliary fuel systems so the full E-15 octane rating technique could be performed. The other eight vehicles were equipped with tachometer and vacuum gauge for determination of transmission characteristics.

30576 (AFME-003) **Energy in cities.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1987. 313p. (In French). (CONF-8706413--: Energiville colloquium, Sophia-Antipolis (France), 4-5 Jun 1987). Order Number DE90784641. Available from NTIS (US Sales Only), PC A14/MF A01.

The energy utilization in the different aspects of a city (space heating, equipments, lighting, street signaling, transport and vehicles, etc.) is studied in the various themes of this congress. Examples are given where energy conservation opportunities are developed: industrial thermal waste up grading for district heating, domestic wastes conversion for space heating, micro-scale hydroelectric power plants, electric transportation public system (tramway), architectural optimization for natural space heating, energy management in city management (space heating, transportation...).

30577 (AFME-82.066.4) **Rational use of energy in industry and transportation. 1982-1985 operation reports.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1987. 700p. (In French). (AFME-85.91.1002.4). Order Number DE90784627. Available from NTIS (US Sales Only), PC A99/MF A01.

This document reviews the annual activity reports of the PIRSEM (a French R and D Agency) concerning the various research domains aiming at enhancing the rational use of energy: heat transfers, combustion and reactive flows, drying, corrosion problems, polyphasic reactors, modelization of conbustion motors, combustion gas catalysis, etc. For each project, the financement, research teams or societies, involved, goals and achievements are reviewed.

30578 (BFI-1124) **Energy conservation in heating furnaces by lining with modern fibrous insulating materials. Final report.** Schulte, M.; Klima, R. Verein Deutscher Eisenhuettenleute (VDEh), Duesseldorf (Germany, F.R.). Betriebsforschungsinstitut; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1989. 157p. (In German). Contract BMFT 03 E-8172-A. Available from Copy held by UB/TIB Hannover.

By means of simulation calculations energy saving by lining various furnace models with fibrous insulating materials was determined. For this determination both the lining only with fibrous insulating materials and the use of fibrous insulating materials as an additional thermal insulation on the hot side of heavy fireproof lining were considered. The results allow an estimation of the possible energy saving also for other furnaces and modes of operation. The thermodynamic parameters of the lining were determined. For this purpose an instationary measuring method was developed for the determination of the temperature-dependent coefficient of thermal conduction of fibrous insulating materials. Furthermore a special probe was developed for the direct measurement of the heat flow density. From a summarized evaluation of the investigation results it can be concluded that an exclusive or additional lining with ceramic fiber insulating materials shows a high economic efficiency even at the present low energy price. (UA).

30579 (EC/TS-IP90) **A guide to implementation and operation of vehicle emissions inpection clinics.** Cope, D. (Transportation Systems Div., Environment Canada, Ottawa, ON (Canada)); Lavallee, F.; Solman, R. Environment Canada, Ottawa, ON (Canada). Transportation Systems Div. Jun 1988. 101p. (MICROLOG-90-02382). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Vehicle emissions inspection clinics are a method of advertising an environmental agency's work in the field of vehicle emissions and their control and for disseminating information to the public. They can also serve as a source of data with respect to the in-use fleet of vehicles in a particular area. Ideas for and suggestions on how to plan, organize and run an inspectional clinic are presented in this report. Agencies are encouraged to collect data following the standard format outlined in the text. Standardization of data recording will provide information which is more cross-comparable than may have been the case for previous clinics. 9 refs., 5 figs., 2 tabs.

30580 (MU/CRT-638) **Strategic planning of freight transportation in Brazil: Methodology and application: Part 1, Project summary.** Florian, M.; Crainic, G. (eds.). Montreal Univ., PQ (Canada). Centre de Recherche sur les Transports. Jul 1989. 47p. (MICROLOG-90-01417). Available from PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The principal aims of this collaborative project between the Brazilian government and the University of Montreal was to develop the means and the methods for evaluating contemplated changes in the freight transportation infrastructure in Brazil, with particular

emphasis on energy consumption. The planning methods and the data base that supports these methods were to be implemented in Brazil and provide the capability for carrying out strategic planning exercises on a continuing basis. The report consists of 5 parts, of which part 1 is a summary stating the main objective of the project, reviewing its history and summarizing the achievments made in the new methodological contributions, the development of the STAN system, the specification of data for use with the STAN system, the applications carried out, and a conclusion on the entire project. Numerous seminars were conducted in Brazil to explain and disseminate the new methodology and to instruct the eventual users of the STAN system in all its aspects. The analysis and descriptions of the Brazilian context of freight transportation, the policy issues involved in national freight transportation planning and the analysis of the data sources required provided the team with a unique opportunity to learn the problems faced by developing countries such as Brazil. The approach used in the project is sufficiently general to be used in other developing countries. 12 figs.

30581 (MU/CRT–639) **Strategic planning of freight transportation in Brazil: Methodology and application: Part 2, Methodology: The new contributions.** Florian, M.; Crainic, G. (eds.). Montreal Univ., PQ (Canada). Centre de Recherche sur les Transports. Jul 1989. 258p. (MICROLOG–90-01418). Available from PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This collaborative project among the Brazilian government, the University of Montreal and the Pontificia Universida de Catolica do Rio de Janeiro was to develop the means and methods for evaluating contemplated changes in the freight transportation infrastructure in Brazil, with particular emphasis on energy consumption. The planning methods and the data base that supports these methods were to be implemented in Brazil and provide the capability for carrying out strategic planning exercises on a continuing basis. The report consists of 5 parts, of which part 2 describes the new methodological developments motivated by the strategic freight transportation problems considered in the project. It contains the general modeling framework developed, as well as the specific representation of various transportation modes that result by using this modelling approach. The formulation and solution algorithms for the multimode multiproduct network assignment method, which is the main new development of the project, is described in detail. An approach to computing maximal multimode multiproduct network flows is given as well. 68 figs., 47 tabs., 77 refs.

30582 (MU/CRT–640) **Strategic planning of freight transportation in Brazil: Methodology and application: Part 3, the Star system.** Florian, M.; Crainic, G. (eds.). Montreal Univ., PQ (Canada). Centre de Recherche sur les Transports. Jul 1989. 103p. (MICROLOG–90-01423). Available from PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This collaborative project among the Brazilian government, the University of Montreal and the Pontificia Universidade Catolica de Rio de Janeiro was to develop the means and methods for evaluating contemplated changes in the freight transportation infrastructure in Brazil, with particular emphasis on energy consumption. The planning methods and the data base that supports these methods were to be implemented in Brazil and provide the capability for carrying out strategic planning exercises on a continuing basis. The report consists of 5 parts, of which part 3 describes the main features of STAN, the interactive-graphic planning system for the strategic analysis of multimode multiproduct transportation networks at the regional and national levels that was developed from the project. 7 figs., 5 tabs., 13 refs.

30583 (MU/CRT–641) **Strategic planning of freight transportation in Brazil: Methodology and application: Part 4, Specifying data for the Stan system: Requirements, concepts, sources and estimation procedures.** Florian, M.; Crainic, G. (eds.). Montreal Univ., PQ (Canada). Centre de Recherche sur les Transports. Jul 1989. 171p. (MICROLOG–90-01424). Available from PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This collaborative project among the Brazilian government, the University of Montreal, and the Pontificia Universida de Catolica do Rio de Janeiro was to develop the means and methods for evaluating contemplated changes in the freight transportation infrastructure in Brazil, with particular emphasis on energy consumption. The planning methods and the data base that supports these methods were to be implemented in Brazil and provide the capability for carrying out strategic planning exercises on a continuing basis. The report consists of 5 parts, of which part IV describes the data that is required as input to the strategic planning system. The sources are specific to Brazil, while the concepts and the estimation procedures are general in nature and of broader interest and applicability. 52 tabs., 5 figs., 55 refs.

30584 (MU/CRT–642) **Strategic planning of freight transportation in Brazil: Methodology and application: Part 5, Applications.** Florian, M.; Crainic, G. (eds.). Montreal Univ., PQ (Canada). Centre de Recherche sur les Transports. Jul 1989. 178p. (MICROLOG–90-01425). Available from PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This collaborative project among the Brazilian government, the University of Montreal, and the Pontificia Universidade Catolica do Rio de Janeiro was to develop the means and methods for evaluating contemplated changes in the freight transportation infrastructure in Brazil, with particular emphasis on energy consumption. The planning methods and the data base that supports these methods were to be implemented in Brazil and provide the capability for carrying out strategic planning exercises on a continuing basis. The report consists of 5 parts, of which part V describes the applications realized during the project by using STAN. The particular context of strategic freight transportation planning in Brazil is presented, then the first application, which deals with the description of the strategic corridors and the demand for transportation in Brazil, is described. The second application, which is the study of the development of the transportation system of the Sao Francisco corridor, concludes the report. The STAN system proved to be an analysis tool of great potential for the strategic planning of the transportation sector by extrapolating the analysis of flow distribution through the transportation network and by permitting the multimodal network to be characterized in terms of inventory and utilization under various demand hypotheses. It also allowed the transportation demand information to be validated by product for projected flow estimates. 32 tabs., 94 figs.

30585 (PB–90-172933/XAB) **Transit issues and recent advances in planning and operations techniques.** Guenthner, R.P.; Hamat, K.; Haboian, K.A.; Koffman, D.; Nygaard, D. National Research Council, Washington, DC (USA). Transportation Research Board. 1988. 129p. (TRB/TRR–1202). Available from NTIS, PC A07/MF A01.

Library of Congress catalog card No. 89-13186.

The 15 papers in the report deal with the following areas: Distribution of bus transit on-time performance; Planning guidelines for transitway access; Assessing the accuracy of driver passenger counts: the experience of AC transit; Multi-centered time-transfer system for Capital Metro, Austin, Texas; Coordination of Public Transit and School Bus Transportation Programs: results of pilot projects in six Iowa communities; Use of future scenarios in long-range public transportation planning; Practical approach for solving school bus problems; NJ TRANSIT process for evaluating capital projects; Three-step operations planning procedure for transit corridor alternatives analyses; Design of public transport networks; Bus transit subsidies in Connecticut; Estimating unmet travel needs using secondary data sources; Bus and subway integration in Seoul:

a case of doing nothing; Demand for intercity bus by the rural elderly; Organization of urban public transport in France: lessons for developing countries.

30586 (PB–90-173113/XAB) **Transit administration and planning research.** de Corla-Souza; Gupta. National Research Council, Washington, DC (USA). Transportation Research Board. 1989. 83p. (TRB/TRR–1209). Available from NTIS, PC A05/MF A01.

Library of Congress catalog card No. 89-13941.

The 10 papers in the report deal with the following areas: Evaluation of demand-management strategies for Toledo's year 2010 transportation plan; Accommodating deaf and hard-of-hearing persons on public transportation systems in Massachusetts; Quick approach to compare highway and bus transit alternatives using the arterial analysis package; Panel survey approach to measuring transit route service elasticity of demand; UMTA and major investments: evaluation process and results; Using early performance to project transit route ridership: comparison of methods; Institutional requirements for competition: labor issues; Updating ride checks with multiple point checks; Producing section 15 service-consumed data: challenge for large transit; Parkrose targeted marketing campaign pass-incentive program.

30587 (PB–90-180340/XAB) **Cost-saving methods for special transportation programs. Final report.** Louisiana Dept. of Transportation and Development, Baton Rouge, LA (USA). Dec 1988. 30p. Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

In 1987, the Louisiana Department of Transportation and Development (DOTD) participated in a demonstration project with the Urban Mass Transportation Administration aimed at reducing capital and operating expenses for Section 16(b)(2) operators. The Louisiana DOTD contracted with Urban Systems, Inc., a transportation consulting firm, to work with Section 16(b)(2) operators in Orleans and Tangipahoa Parishes to find a number of ways to reduce transportation operating costs and to improve transportation services for the elderly and handicapped. The manual presents nine different methods that the contractor identified to help Section 16(b)(2) operators throughout Louisiana to reduce transportation operating costs and to improve transportation services for the elderly and handicapped. Most of the techniques are generally applicable in other states and can be used by operators nationwide.

30588 (UCRL–99623) **A light gas gun system for launching building material into low earth orbit.** Hunter, J.W.; Hyde, R.A. Lawrence Livermore National Lab., CA (USA). 3 Jul 1989. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8907118–2: 25. ASME/AIAA joint propulsion conference, Monterey, CA (USA), 10-13 Jul 1989). Order Number DE90010745. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A vital element for space exploration is the ability to place large quantities of building materials into low earth orbit. Our calculations indicate this can be done using a hydrogen gas gun specifically designed to launch metric ton size packages. Atmospheric drag, gravity, and the necessity to raise the perigee will require a single stage rocket to supply the additional 1-4 km/sec. We present a launcher design which features reliability and low maintenance as well as simplicity. The launcher will deliver masses ranging from 1000 kg to 4000 kg at velocities between 7.1 km/sec and 4.7 km/sec respectively. Our system is a straightforward tailoring of two stage hydrogen gas gun technology. Each system is capable of delivering over 1000 metric tons of payload into low earth orbit annually. 3 refs., 9 figs.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 29959, 29987, 29990, 29991, 29992, 30079, 30082, 30202, 30446, 30464, 30504, 30519, 30526, 30577, 30666, 30846, 30869, 31277, 31319

30589 (AD-A–217452/2/XAB) **Fluorinated diamond thin films for tribological applications. Final report, April-October 1989.** Freedman, A.; Stinespring, C. Aerodyne Research, Inc., Billerica, MA (USA). 4 Jan 1990. 22p. (ARI-RR–750). Available from NTIS, PC A03/MF A01.

Diamond (100) substrates have been fluorinated with both atomic and molecular fluorine under ultrahigh vacuum conditions using molecular beams. X-ray photoelectron spectra of the resulting samples indicate that atomic fluorine, F, reacts with an initial accommodation coefficient of 0.25 (+ or - 0.1) at 298 K; a saturation coverage of about three quarters of a monolayer is obtained. The carbon fluoride adlayer is thermally stable to 700 K, but slowly desorbs at temperatures above this. In contrast, molecular fluorine, F2, reacts quite slowly; a saturation coverage of less than one fifth of a monolayer after several hundred monolayers exposure to F2 at temperatures from 300 K to 700 K is achieved. In addition, diamond substrates saturated with fluorine atoms showed no loss of fluorine after exposure to beams of H2 and O2 at temperatures between 300 K and 700 K.

30590 (AFME-FR–22) **Maintenance and energy conservation: a hand book for energy managers and maintenance engineers.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). 1986. 52p. (In French). Order Number DE90784633. Available from NTIS (US Sales Only), PC A04/MF A01.

This hand book is designed as a check-list to be used by maintenance and energy specialists in order to optimize the operation of energetic equipments and enhance productivity and efficiency: savings at the vapor production level, at the vapor or hot water distribution level, savings at the industrial space heating and ventilation level, at the compressed air distribution system level, at the electric power distribution level and at the lighting level. Ratios calculations are presented.

30591 (CICS–CE02996, pp. 20-23) **Energy conservation in industrial combustion systems.** Preto, F. (Energy Research Laboratories, CANMET, Ottawa, ON (Canada)); Hayden, A.C.S. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The Combustion and Carbonization Research laboratory has carried out a pre-engineering assessment program (ENERSOLVE) aimed at increasing the utilization efficiency of oil and gas in industrial boilers, kilns and furnaces. The impetus for these studies was that much of the existing equipment, ten or more years old, might be operating inefficiently, and technical upgrading the installation could achieve greater fuel economy. The ENERSOLVE assessments consisted of four specific tasks: identification of the oil and gas burning industrial units which showed potential for improved energy utilization efficiency; on-site testing to establish data on fuel use, combustion system efficiency, process load characteristics, and potential uses for recovery energy; outlining of equipment upgrading and retrofit procedures to improve efficiency; and estimation of cost for implementing modifications and monitoring performance. A number of industries were examined, ranging from steel manufacturing plants and foundries to dairies and breweries. The industries which were found to be the most energy intensive were the cement and similar industries. Improvements have been identified which can substantially improve the energy utilization efficiency of kilns and dryers. Gains of at least 10-15% can be obtained by providing insulation, sealing leaks, improving combustion efficiency and improving operating and maintenance procedures. The simple payback periods for these measures range from 1-2 years. Additional savings can be obtained by modernizing the combustion systems. 1 tab.

30592 (CONF-891287–1) **Using environmental risk assessment to evaluate chemical waste disposal in developing countries.** Habegger, L. (Argonne National Lab., IL (USA)); Fingleton, D.; Liengcharernsit, W.; Hastings, P. Argonne National Lab., IL (USA). Nov 1989. 7p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-31109-ENG-38. From U.S.-India workshop on environmental risk; New Delhi (India); 12-16 Dec 1989.

Order Number DE90010473. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Rapid industrialization of countries in the Pacific Basin has been accompanied by dramatic increases in the manufacture, formulation, use, and disposal of hazardous materials and residuals. Countries, particularly those with more developed industrial economies, have implemented waste management strategies in various ways and to varying degrees. Although existing strategies provide useful guidance for developing and newly industrialized countries, each country must consider various factors as it independently develops approaches adapted to its particular circumstances. For example, individual strategies must take into account the types and quantities of wastes being generated or those projected to be generated as a result of anticipated economic development; the ability to access trained staff and capital for effective use of available technologies; the environmental and demographic setting of the alternative sites of the associated facilities; the perceptions as to what risks are acceptable relative to other possibly more traditional health and safety risks; and the institutions available for implementing the waste management strategy. This paper discusses how the principles of risk assessment and comparison can be a constructive force in thinking through these complex decisions and describes how a risk-based analysis contributed to the development of a hazardous waste management strategy in Thailand. 6 refs.

30593 (CONF-8810352–, pp. 9-28) **Development criteria for innovative automation of industrial processes in metallurgy.** Bologna, S. (ENEA, Centro Ricerche Energia, Casaccia (Italy)); Conte, A.; Federico, A. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper deals with the new standards of automation for industrial metallurgical processes. After a short analysis of common automatic processes, an examination is made of some particular metal industry shops in Italy, in which, with the intervention of ENEA (Italian Commission for Alternative Energy Sources)improvements were made relevant to basic process control equipment, equipment coordination schemes, and information system-production area interfaces. The innovative aspects involved the adoption of intelligent sensors, distributed computation capabilities, entire-plant communication networks, graphic interface work stations for supervisory personnel and operators, software for the development and qualification of computer programs, as well as diagnostics and man-machine expert systems.

30594 (CONF-9002116–1) **Transformation of high-carbohydrate food wastes into degradable plastics.** Bonsignore, P.V.; Tsai, S.P.; Tsai, T.S.; Coleman, R.D. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Conference on fermentation technologies; Palmerston North (New Zealand); 12-15 Feb 1990. Order Number DE90010414. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An abundant and little-used resource that is available for bioconversion to higher value products is our own agricultural waste streams. Billions of pounds of carbohydrates in food waste can be readily bioconverted to products such as lactic acid. Argonne is developing a process to rapidly convert starch in potato waste to D- and L-lactic acid. Prime considerations are the cost of production and end used for lactic acid such as degradable materials, mostly for agricultural applications in mulch films, sustained-release systems for fertilizers and pesticides, etc. This paper reports other applications for polylactic acid and plastics and also discusses the prototype process being developed at Argonne to make low-cost lactic acid. 1 tab.

30595 (CP/MJ–FP44) **Rendering vapour waste heat recovery project: Final technical report.** Canada Packers, Inc., Moose Jaw, SK (Canada). [1984]. 24p. (CE–02942). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In December of 1982, Canada Packers Inc., started up a rendering vapour hear recovery system at its Moose Jaw Packinghouse plant. The system recovers previously lost waste heat from the vapor produced by four batch inedible rendering cookers. The vapour, which has the properties of saturated atmospheric steam, is cooled and condensed by incoming city water in a spiral type heat exchanger. The city water is preheated to about 65 °C before it enters the plant's existing hot water heating system. Its temperature is then adjusted to the desired temperature by steam heating. The hot water is used for processing and sanitation. The system has performed well during its first eight months of operation. There have been no unscheduled shutdowns. The rate of heat recovery averaged 3.90 GJ/h on the day shift and 1.19 GJ/h on the clean-up shift. The system is recovering about 77 percent of the available waste heat. Based on these results, the annual fuel savings have been estimated to be in excess of 477,000 m^3 of natural gas. The $140,745 captial cost of the project was partially offset by $26,190 grant from the Canada/Saskatchewan Conservation and Renewable Energy Demonstration Agreement (CREDA). The first year savings have been estimated to be about $53,000. Thus the simple payback will be 2.66 years with the grant and 2.16 years with the grant. 2 figs., 4 tabs.

30596 (EGG-M–90055) **Iron bath smelting - current status and understanding.** Fruehan, R.J. Carnegie-Mellon Univ., Pittsburgh, PA (USA). [1990]. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-89ID12847. (CONF-9006163–1: Elliot symposium – ISS-AIME, Boston, MA (USA), 10-13 Jun 1990). Order Number DE90009643. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Currently there is a worldwide effort to develop an iron and steelmaking process which uses coal directly rather than coke for reduction and energy. The most promising of the new processes is Bath Smelting in which coal, iron ore and oxygen or air are reacted in an iron bath. Research and development of the process is underway in Europe, Australia, Japan and the USA; while other countries are planning work for the near future. A brief description of the processes and the current state of their development is briefly discussed. The current state of knowledge on the critical basic phenomena which control bath smelting are reviewed. The major production limiting processes, reduction of iron oxide, heat transfer and slag foaming are discussed. A simple reduction model is presented which predicts how the production rate will vary with operating parameters and estimates the rate itself. From the foam index for smelting slags, and the gas generation for the specific operating conditions, the foam height in the process can be estimated. Coke in the slag can significantly reduce slag foaming. Future developments are briefly discussed. 15 refs., 16 figs., 1 tab.

30597 (FSC–CE02972) **Refrigeration waste heat recovery.** Ferguson, Simek, Clark Ltd., Yellowknife, NT (Canada). Mar 1983. 32p. (CE–02972). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

UK Super A Stores was built in 1972 and is part of a small indoor shopping complex linked together by a heated mall. The store has a public floor area of approximately 1,232 m^2 (13,261 $ft.^2$) and sells the usual variety of food produce including a large selection of frozen foods. There are five lengths of refrigerated display cabinets with a total area of approximately 78 m^2. There are also some frozen food storage rooms at the back of the store. This report provides a description of a waste heat recovery system within a medium sized food store. It details how the waste heat that is produced by the conventional frozen food display cabinets, can be reused by the store's space heating system. Recommended uses for this waste heat include: diverting to the loading bays which would make the reheat coil unnecessary, diverting to the front of the shop, and heating the adjacent shopping mall. The CREDA (Conservation and Renewable Energy Demonstration Assistance) program contributed $17,444 towards the total project cost of $30,444. The project was initiated by the store owner, who is now realizing a lower annual fuel consumption, with the resulting financial savings. 11 figs., 1 tab.

30598 (NBES–2014) **CAMR woodchip heating, Community Industries Ltd., Woodstock, N.B.** Department of Energy, Mines and Resources, Ottawa, ON (Canada); New Brunswick Energy Secretariat, Fredericton, NB (Canada). Jan 1985. 19p. (CE–02888). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This project consisted of installing a wood chip burning system at the workshop division of the Canadian Association for the Mentally Retarded in Woodstock, New Brunswick. The heating system is comprised of a large storage bin, a feed conveyor, a gasifier, and a wood-burning furnance. It successfully heats a 372 sq. m. (4,000 sq. ft.) workshop. The entire system displaces 6000 litres of fuel oil per year. The chip test and furnance efficiency test performed while burning the dryest chips (14% moisture) produced a furnance efficiency of 81%. This indicates a good performance for the gasifier-overfeed technology combined with a hot air furnance. It was felt that the overall efficiency is augmented with drier chips. Burnback and creosote deposits occur because of excessive moisture chips resting in the top half of the hopper. If the burner were operating under load, there would be less of a chance for burnback and creosoting. This means that leaving the unit burning unattended at a low thermostat setting for more than 12 hours is not recommended. It can be recommended that this kind of system be used by any small or medium-sized business whose objective is to reduce its heating costs and do so in a safe and practical manner. 2 figs., 5 tabs.

30599 (NBES–2040) **Fish oil as an alternative fuel: Final report.** Walch, W.N. (Connors Bros. Ltd., Blacks Harbour, NB (Canada)); Stevens, F. New Brunswick Energy Secretariat, Fredericton, NB (Canada). Dec 1984. 57p. (CE–02973). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The object of this demonstration project was to investigate the feasibility of using fish oil as an alternative fuel. The project was completed between May 1982 and April 1983 with financial assistance from the Canada Conservation and Renewable Energy Demonstration Program (CREDA). Connors Bros. produces from 400,000 to 500,000 gal/y of fish oil. The market for fish oil has dropped in the past 4 years, whereas that of residual fuel oils has increased by over 250%. Fish oil as a fuel, if feasible, could replace 90% of the residual fuels used in Connors' two largest operations at Black Harbour, N.B. The physical and chemical properties of fish oil show it to be a viable fuel oil. When comparing it to residual fuel oils fish oil is found to have a pour point, flash point and viscosity level similar to a no. 4 oil. The major deficiency of fish oil is a loss of heat content of 14.5% when compared with 6 Bunker C oil on a volume basis. Fish oil was burnt in two fishmeal driers, a Cleaverbrooks boiler (200 hp) and a Volcano water-tube boiler (35,000 lbs/h). The Volcano was monitored for a month while 23,000 gal of fish oil were burnt under production conditions and the results compared with those of number 6 Bunker C oil. Several fishing companies began burning fish oil for processing and heating as a result of the Connors experience. They have since stopped due to a sudden increase in the price of fish oil. In conclusion, it was found that fish oil is a viable technical alternative to residual fuel oils. 5 figs., 7 tabs.

30600 (NP–SPE3/HA/6) **Treatment of leadbearing residues in a rotary kiln.** Serie de rapports de la protection de l'environnement. Nova Pb, Inc., Ville Ste-Catherine, PQ (Canada). Jun 1989. 38p. (MICROLOG–89-05565). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Between January and March 1988, 711,775 kg of lead and chrome bearing residues from Heubach Inc., the largest manufacturer of inorganic or organic pigments in the United States, were processed by NOVA Pb Inc. This report describes the smelting process, using the rotary kiln as the smelting technology together with three additives: soda ash, coke, and iron; the product; and environment, economic, and energy-saving benefits as they relate to the treatment of the Heubach material and similar lead-bearing residues. One average load, weighing 16177 kg, cost Can $9376 for recycling and produces 5484 kg of lead, worth Can $5095. NOVA is now ready to accept lead-bearing industrial wastes and to process them according to metallurgical and environmental standards; this is much preferable to burying the wastes in approved dump-sites. 3 figs., 16 tabs.

30601 (PB–90-178757/XAB) **Consumption trend analysis in the industrial sector: Regional historical trends. Draft report (Final).** Resource Planning Associates, Inc., Washington, DC (USA). May 1981. 174p. (RPA–80-0429(3)). Available from NTIS, PC A08/MF A01.

Data on the use of natural gas, electricity, distillate and residual fuel oil, coal, and purchased coke were collected from the United States Bureau of the Census and aggregated nationally and by Census Region. Trend profiles for each fuel and industry were developed and economic, regulatory, and regional factors contributing to these trends were examined. The recession that followed the OPEC embargo in 1973 affected the industrial sector and the heavily industrialized regions of the country most severely. Both industrial production and fuel consumption fell significantly in 1975. As production recovered, spiraling fuel prices promoted conservation efforts, and overall fuel consumption remained at pre-recession levels. From 1975 to 1977 natural gas consumption decreased in almost all the industries examined with curtailments of gas supplies contributing to this trend.

30602 (PB–90-862343/XAB) **Waste-paper recyling in the packaging industry. January 1982-August 1989 (a Bibliography from Packaging Science and Technology Abstracts data base). Report for January 1982-August 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 62p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the reclamation and re-use of waste paper in the packaging industry. Uses of recycled papers include containers, paper manufacture, paperboard products, and other packaging applications. Economics, environmental impacts, legislation, and feasibility studies are included. Problems associated with recycling paper products, and comparisons with plastic products are also considered. Biodegradation of packaging materials is considered in separate bibliographies. (Contains 142 citations fully indexed and including a title list.)

30603 (PB–90-862509/XAB) **Abrasive wear: Theoretical and practical considerations. January 1973-November 1987 (a Bibliography from Information Services in Mechanical Engineering data base). Report for January 1973-November 1987.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 128p. Available from NTISPC N01/MF N01.

See also PB–90-862517.

This bibliography contains citations concerning theoretical, experimental, and practical considerations of abrasive wear of various materials, types of surfaces, tools, machinery, equipment, etc. Wear mechanisms, wear resistance, wear rates, and wear protection are emphasized. (This updated bibliography contains 333 citations, none of which are new entries to the previous edition.)

30604 (PB–90-862517/XAB) **Abrasive wear: Theoretical and practical considerations. December 1987-August 1989 (a Bibliography from Information Services in Mechanical Engineering data base). Report for December 1987-August 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 29p. Available from NTISPC N01/MF N01.

Supersedes PB–88-853007. See also PB–90-862509.

This bibliography contains citations concerning theoretical, experimental, and practical considerations of abrasive wear of various materials, types of surfaces, tools, machinery, equipment, etc. Wear mechanisms, wear resistance, wear rates, and wear protection are emphasized. (This updated bibliography contains 56 citations, all of which are new entries to the previous edition.)

30605 (PB–90-862640/XAB) **Solid-waste disposal economics. March 1986-February 1990 (a Bibliography from the**

NTIS data base). Report for March 1986-February 1990. National Technical Information Service, Springfield, VA (USA). Mar 1990. 76p. Available from NTISPC N01/MF N01.

Supersedes PB–89-866412.

This bibliography contains citations concerning economic aspects of solid waste disposal. Topics include feasibility studies of specific waste-to-energy programs, materials recovery and recycling, and the use of fuel gases from landfills. Waste materials sources include industrial and municipal wastes, dredged materials, and waste derived from agricultural and mining operations. Considerable attention is given to Superfund records of decision at specific sites. (This updated bibliography contains 119 citations, 38 of which are new entries to the previous edition.)

3206 Municipalities and Community Systems

Refer also to citation(s) 30186, 30463, 30570, 30576, 30605, 31413

30606 (CONF-9003147–1) **Studies of soil gas, gas generation, and shallow microbial activity at Mallard North Landfill, Dupage County, Illinois.** Bogner, J.E.; Vogt, M.; Miller, R.M. Argonne National Lab., IL (USA). [1990]. 18p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 13. international landfill gas symposium; Lincolnshire, IL (USA); 27-29 Mar 1990. Order Number DE90010102. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three types of investigations at the Mallard North Landfill during the last five years have led to the development of useful field and laboratory techniques for better understanding gas generation, gas migration, and shallow microbial processes at any landfill. This paper summarizes the techniques with reference to representative results from Mallard North and discusses their general applicability to landfill site investigations. 29 refs., 5 figs., 1 tab.

30607 (EMR/OEC–CE02986) **A new and novel form of district heating using thermal effluents from electricity generating plants.** McLoughlin, G.T.; Reinbergs, M. Department of Energy, Mines and Resources, Ottawa, ON (Canada). Office of Energy Conservation. Dec 1977. 42p. (CE–02986). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Most electricity-generating nations exploit no more than 30% of the energy available in the fuel and the industries using process steam, generally no more than 25%. However, using cogeneration, it is feasible to capture 80% of the available energy by energy upgrading and at the expense of a small quantity of energy invested to raise the average temperature of a process, large quantities of heat become utilizable. Although there are many possible applications of energy upgrading, this concept is illustrated in the domain of district heating and hot water. The possibility of using the thermal effluents of the Pickering and Lakeview nuclear generating stations to supply the heating needs of the city of Toronto is evaluated. The paper discusses the use of the thermal effluents from electricity generating stations to preheat the domestic hot water supply, the purification of the heated discharge from power plants for municipal water supply, a district heating scenario, the rationale for the choice of a low temperature district heating system, the heat losses in a buried hot-water pipe, the capacity of storm sewers to handle heat-pump run-off, and heat pump performance and characteristics. The capital cost for a preheat water delivery of 480 Mgal/d would be Can $27.9 M and the pay-back period for no heat pump customers would be 1.4y. This calculation does not take into account the environmental advantage of ending the thermal pollution of the power plants. The economics can be further improved by upgrading the heat through domestic heat pumps. A somewhat similar American study is discussed at the end of the report. 21 refs., 8 figs., 7 tables.

30608 (PB–90-163106/XAB) **Methods to manage and control plastic wastes. Report to the Congress.** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Feb 1990. 388p. (EPA–530/SW-89/051). Available from NTIS, PC A17/MF A03.

The report is the compilation of data gathered by EPA in response to the U.S. Japan Fishery Agreement Approval Act of 1987. The focus of the report is plastic wastes in the municipal solid waste stream; the amount of such waste; its impact on human health, the environment, and management of the MSW stream (post-consumer plastic waste); and options for reducing these impacts (recycling).

30609 (PB–90-174897/XAB) **Facing America's trash: What next for municipal solid waste. Summary report.** Office of Technology Assessment (U.S. Congress), Washington, DC (USA). 1990. 51p. Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The contents of this study include: policy options; enhancing the institutional framework; specific msw program options; (waste prevention, recycling, incineration, landfills); and concluding remarks.

30610 (YEDT–CE02912, pp. 117-187) **District heating in the N.W.T. for diesel generator supported communities.** Ferguson, D. (Ferguson, Simek, Clark Ltd., Yellowknife, NT (Canada)); Eng, P. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This presentation reviews the evolution of district heating in the Northwest Territories, of diesel generator supported communities and discusses the design and administrative considerations associated with waste heat recovery in the Arctic. A specific installation in a school is described from concept through design, construction and operation. The school heating system was designed to be completely self-contained, with two oil-fired boilers capable of providing the necessary heat. The intention of the design was to use as much of the waste heat from the Northern Canada Power Commission (NCPC) generating plant as possible. This meant that the school boilers' operations were kept to a minimum. It was anticipated that some peaking at design conditions would be required from the boilers. The Power Commission controlled the design for the in-plant portion of the work so that it had complete control of space planning in its own facilities and complete responsibility for maintenance. 29 figs., 10 tabs.

30611 Making connections between research and program implementers: An example of federal initiative. . Kirchen, S. (U.S. Dept. of Energy (US)). vp. of National and regional conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808244–: National and regional conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

As a result of changes in the legislative mandate for the Residential Conservation Service Program, the Residential and Commercial Conservation Branch (RCCB) of the U.S. Department of Energy has gained responsibilities to provide technical assistance to State and utilities in support of residential and commercial conservation programs. The author discusses how RCCB has initiated a variety of strategies to deliver its research and program results to program implementers and planners. A summary report will describe RCCB's technology transfer plan and activities. The report will discuss the types of research results RCCB emphasizes and the mechanisms instituted both to enhance the usefulness of research results through appropriate communication channels. The problems of presenting research findings in a user-friendly fashion for state and utility program managers will be specifically addressed.

30612 Energy efficiency decision-making in chanins and franchises. Hobson, C.A. (Bonneville Power Administration (US)); Gordon, F.M.; Baylon, D.; Katz, G. vp. of Utility and private sector conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808245–: Utility and private sector conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

A significant proportion of the commercial floor space in retail grocery stores, restaurants, and dry goods stores is managed by

chains and franchises. The task of marketing energy services to these organizations is very different than the task of marketing to independently owned businesses. The Bonneville Power Administration contracted a detailed study of how the largest chains and franchises in the Pacific Northwest make decisions about energy conservation investments in new and existing commercial buildings. The study provides a detailed picture of decision-making processes, current building stock efficiencies, equipment, and fuels, and program needs for each of the selected chains. This paper summarizes the methodology used in the study, provides a decision-making profile of each building type studied, and draws some conclusions for energy conservation programs.

30613 Designing the least cost/most effective financial incentives in the commercial sector. Jamieson, D. (Bonneville Power Administration (US)); Keating, K. vp. of Utility and private sector conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808245–: Utility and private sector conservation programs, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper describes the financial incentive structure designed for the Commercial Incentives Pilot Program (CIPP) a $15 million, 5 year capability building and commercial conservation effort in the Pacific Northwest. It includes an analysis of the decision making process in setting the various financial incentives in the design process of CIPP (1985-1986) as well as analyzing the actual incentives paid in 1987 and 1988 to 200 building owners who have invested in the energy efficiency of their buildings. A review of methods that were used to calculate and implement the various incentives is provided.

30614 Sludge suspension in waste storage tanks. Hamm, B.A. (Actinide Technology Div., Savannah River Lab., Aiken, SC (US)); West, W.L.; Tatterson, G.B. *A.I.Ch.E. Journal (American Institute of Chemical Engineers) (USA)*, 35(8): 1391-1404 (Aug 1989).

In large storage tanks, jets rather than impellers are used for mixing and solid suspension. Jets often are formed by submerged rotating pumps, commonly referred to as slurry pumps. In sludge suspension applications, the jets from the slurry pumps form circular sludge-free cavities. The radius of these circular cavities, called the cleaning radius, is used often as a measure of the suspension capability of slurry pumps to suspend solid sludges. Although there is considerable technical literature on mixing and solid suspension in impeller-agitated tanks, studies on jet-induced suspension of a paste or sludge in large storage tanks using slurry pumps are unavailable in the open published literature. The objective of this paper is to determine how the cleaning radius and suspension rate change with time for a typical sludge material and to provide a phenomenological model which explains the results in a general fashion.

3209 Education and Public Relations

30615 (NBES–2025) **Grade 10 energy education course trial: Final report.** New Brunswick Energy Secretariat, Fredericton, NB (Canada). Feb 1985. 57p. (CE–02976). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

One of the projects funded by the Canada/New Brunswick Conservation and Renewable Energy Demonstration Program was an energy educating project of the New Brunswick Department of Education. Its purpose was to enrich the energy conservation content of the high school grade 10 physical science course through the incorporation into the course of a two-week demonstration project. The demonstration project illustrates the importance of energy conservation and the use of renewable sources of energy. The educational materials were developed in both official languages and include instruction manuals, laboratory experiments and a computer-assisted heat loss demonstration with involvement of the students. The materials were developed by a team of educators, writers and technical experts. The process took 16 months and cost Can $29,711. The materials have been evaluated twice, once as a part of the development process and once in 1984. The evaluations show that the aims of the project have been met. Students in the general and occupational program have been provided with instructional materials that have stimulated their interest in energy supply and demand. The program teaches students to differentiate between renewable and non-renewable energy. Using the concepts of energy balance and heat transfer, the students have developed an understanding about the ways to conserve energy in buildings. 8 tabs.

30616 (YEDT–CE02912, pp. 34-40) **Marketing energy conservation: A strategy for the 80's.** Edelle, D.N. (IEA Consulting Group Ltd., Ottawa, ON (Canada)). Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Effective residential energy conservation strategies attempt to optimize the use of energy in the home through the efficient application of energy saving practices, measures and technology. Marrying effective marketing concepts to energy conservation programs is necessary to get good conservation concepts into common use. In developing a marketing strategy for energy conservation it is necessary to define the product or idea in terms of its impact on the householder. Any practice or measure that saves or conserves energy falls within this category. Householders tend to perceive energy conservation as a larger issue and will confuse energy savings with dollar savings. Energy savings will include demand shifts which replace one source of energy with another, potentially cheaper source of energy for example, active and passive solar systems, wood stoves, and furnace conversions. A marketing strategy for energy conservation recognizes that there is a definite process that people follow in deciding whether or not to adopt energy conservation, and that this process is different for low cost, low commitment practices, and maintenance activities, than for higher cost; higher risk measures. 2 figs.

30617 (YEDT–CE02912, pp. 98-103) **Rural residential energy conservation: The North Slope Borough experience in Alaska.** Adams, F. (North Slope Borough Utility Dept., Barrow, AK (USA)); Cogdill, J.; Finkler, E. Department of Energy, Mines and Resources, Ottawa, ON (Canada); Yukon Territory Dept. of Economic Development and Tourism, Whitehorse, YT (Canada). [1985]. (CONF-830001–: 34. Alaska science conference, Whitehorse (Canada), ; CE–02912). In *Towards energy self sufficiency in the North: Energy conservation and forest biomass.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The North Slope Borough in Arctic Alaska is a key area for energy planning and conservation. The Borough stretches over 88,000 square miles and its 5,000 permanent residents in eight villages pay some of the highest energy costs in the nation. Fuel oil can run $3.00/gallon or higher, and it costs the Borough Utility Department almost $1/kWh to generate electricity. The Borough's approach to the problem is headed by the Mayor's office and the assembly, but it features cooperation among various line departments such as Utilities, Housing, and Public Works. In 1981, the Assembly's passage of 12 basic energy policies got the program started on a solid foundation. Subsequent Assembly, mayoral, departmental, village, and resident participation have carried out coordinated actions with increasing momentum. Conclusions drawn from the program are as follows: energy conservation awareness can be created by an initial focus on residential conservation, pilot programs are helpful in identifying improvements, but long term financial support is necessary for such programs to be effective, and the public should be involved in all phases of the program. Education and language are very important considerations. When working with Native people it is important to have staff who speak the language, and illustrations and materials which pertain to

actual local conditions. An ideal rural program mixes outside consultant knowledge of energy, systems, bureaucracy and paperwork with extensive local knowledge of traditional energy conservation, local lifestyles, weather conditions, fuel logistics and cultural preferences.

33 ADVANCED PROPULSION SYSTEMS

Refer also to citation(s) 31746

3301 Internal Combustion Engines

Refer also to citation(s) 30633, 30634, 30635, 30636, 30945, 31745

30618 (AD-A-217237/7/XAB) **Electrostatic dispersion of diesel-fuel jets at high back pressure.** Kwack, E.Y.; Back, L.H.; Bankston, C.P. California Inst. of Tech., Pasadena, CA (USA). Jul 1989. 8p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Engineering for Gas Turbines and Power, Vol. 111, 578-586(Jul 1989).

An experimental study of electrostatically atomized and dispersed fuel jets has been conducted in room temperature N2 gas for various back pressures to 41.8 atm. No. 2 diesel fuel was injected through an electrostatic spray triode designed for high-pressure operation. Charge density measurements were conducted at various combinations of injection velocities, electric potentials, and back pressures. The charge density of fuel drops increased up to 1.5 C/m3 with increasing electric potential until breakdown occurred. After breakdown the charge density was reduced by 40 to 60 percent and again increased but more slowly as electric potential increased. At higher flow rates, breakdown occurred at higher voltages. A higher back pressure, lower charge density was obtained and breakdown occurred at higher voltages. Visual observations showed that significant electrostatic dispersion was accomplished at high back pressures, and that the average drop size was about the same as the spray triode orifice diameter.

30619 (CICS–CE02996, pp. 121-124) **The use of dimethyl ether as a starting aid for methanol-fueled SI engines at low temperatures.** Kozole, K.H. (Toronto Univ., Toronto, ON (Canada)); Wallace, J.S. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Methanol has emerged as one of the most promising alternative fuels for spark ignition engines. Methanol-fueled engines have proven to be difficult to start at ambient temperatures below 10°C. This paper reports results of a project examining the use of dimethyl ether (DME) to improve the cold starting performance of methnol-fueled SI engines. Tests were carried out with a modified single-cylinder CFR research engine having a compression ratio of 12:1. The engine was fitted with a refrigeration system capable of cooling the engine coolant, oil, fuel and inlet air to temperatures as low as -15°C. Gaseous DME was introduced into the engine inlet air through a propane carburetor. Liquid methanol was supplied to the engine through a solenoid-type fuel injector mounted on the intake manifold just outside the intake port. Tests were also carried out with combinations of methanol and DME having DME mass fractions of 30%, 40%, 60% and 70%. For comparison, tests were also carried out with 100% methanol and with winter grade premium unleaded gasoline. All DME/methanol combinations provided good cold starting behavior down to -15°C, the lowest temperature attainable by the refrigeration system. Typically, the engine fired within the first 10 seconds of cranking. The engine started with winter grade gasoline even at -15°C, but required increasingly longer periods of cranking as the test temperature decreased. With 100% methanol, the engine started at 10°C but failed to start at 5°C. Results show that lean mixtures of DME and air would be used to fuel the engine during cranking. After the first fired cycle is sensed, liquid methanol injection would begin. Ether use would cease when the engine was capable of self-sustaining operation with liquid methanol alone. 5 figs., 1 tab.

30620 (CICS–CE02996, pp. 114-116) **The performance of a single cylinder, spark ignition engine fueled with iso-octane.** Odgers, J. (Laval Univ., Quebec, PQ (Canada)); Kretschmer, D.; Laviolette, M. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This work is part of a major program to investigate the effects of widely differing fuels upon the combustion behaviour and engine performance of spark-ignition engines. Past work has investigated the effects of various alcohols, benzene and an unleaded gasoline. The work reported here investigates the performance of a CFR engine when it is fuelled with iso-octane. This fuel has been chosen to act as a constant base-fuel with which all others will be compared. Its selection has been largely decided by its use as a standard for octane rating. Apart from providing knowledge of the behaviour of different fuels, the program should prove to be beneficial to modelling, since eventually it will enable the various combustion times for the fuels over a wide range of conditions to be defined. The fuel is burned within a single-cylinder, variable compression ratio, ASTM-CFR engine. Air temperature and humidity are controlled by drying the air in an ice-tower and then pre-heating to 311°K. K. After carburation, the fuel/air mixture is heated to 422°K prior to its entering the cylinder. For each condition the following measurements were made - pressure vs. volume and pressure vs. temperature diagrams, fuel flow, exhaust temperature, engine torque, exhaust gas analysis (CO_2, CO, hydrocarbon, NO, NOx, O_2). Compression ratios used were: 5,6,7,8; speed was set at 600 rpm; the equivalence ratio ranged from 0.7 to 1.0; also varied was the spark advance. A total of 100 conditions were compared. 1 refs, 8 figs.

30621 (CICS–CE02996, pp. 111-113) **Knock detection in a current S.I. engine - a comparison between cylinder pressure trace measurements and a factory installed accelerometer knock sensor.** Checkel, M.D. (Alberta Univ., Edmonton, AB (Canada)); Dale, J.D.; Modien, R. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The process of autoignition leading to combustion knock has always limited the maximum output and efficiency of spark ignition engines. With modern electronics, control of air/fuel ratio, EGR, and spark timing are possible, permitting higher compression ratios to be used to increase efficiency at part throttle. With higher compression ratios however, wide open throttle will produce knocking. Thus it is important to have a reliable knock sensor which is not affected by other vibrations generated by the running vehicle. One method, and perhaps the best, is to use the cylinder pressure directly and to analyze this signal for the onset of knock. At present most automobile manufacturers use some form of vibration pick up, external to the cylinder, to detect the onset of knock for control purposes. In this study a spark plug pressure transducer was used to measure cylinder pressures for analysis and comparison with the output signal from a factory installed accelerometer. To evaluate knock a reliable indicator is needed. The method used in this study was the third derivative of cylinder pressure with respect to crankshaft position. Earlier work has demonstrated that this technique could reliably detect the onset of knock and produce a signal that was linearly related to the magnitude of the autoignition pressure rise occurring during knocking combustion. The third derivative knock indicator, based on cylinder pressure measurement in a current production engine, provides a better correlation with the magnitude of the fluctuating pressure during knocking than an accelerometer

mounted on the intake manifold. The knock indicator method was found to be unaffected by changes in engine speed. 2 refs., 6 figs.

30622 (CICS–CE02997, pp. 98-101) **Drop size distribution in dense diesel sprays.** Guelder, O. (National Research Council of Canada, Ottawa, ON (Canada)); Baksh, M.F. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

In Diesel-type intermittent liquid fuel sprays, the temporal and spatial variations of the drop size distribution are important to the combustion process. Of course, the highly transient nature of the phenomena, in addition to the restricted access to the combustion chamber, prevent the measurement of the characteristics of the spray in a running engine. However, a high-pressure combustion bomb with proper optical access allows the measurement of the characteristics of Diesel sprays under controlled conditions. The method of determination of the drop size distrubution by forward laser light scattering is outlined. The experimental set-up and its calibration are described. Time-resolved drop size and size distrubution measurements were conducted using 2 different Diesel injectors, a commercial one used in automotive Diesel engines, and a custom-designed electronic injector which allows the presetting of injection pressure and other operating parameters. The variations of the mean drop size and of the drop size distribution with time at a 50mm downstream location are shown. The different temporal variations of the mean drop sizes of the sprays from the 2 injection pressure, although the 2 injectors have more or less the same mean injection pressure. Some of the drop size distributions are bi-modal, which outlines the insufficiency of characterizing the whole spray with a single mean diameter. 6 refs., 4 figs.

30623 (CICS–CE02997, pp. 71-73) **Swirling combustion in a constant volume chamber.** Pierik, R.J. (British Columbia Univ., Vancouver, BC (Canada)); Hill, P.G. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The objective of this work is to determine the effects of swirl and spark location on combustion duration in a short cylindrical chamber with variable spark location, swirl and turbulence intensity. The experimental apparatus is described; the static pressure transient, as measured with a piezoelectric pressure transducer, provides a measure of the burning rate. The methane-air mixtures used in the experiments were adjusted to stoichimetric compostion using the partial pressure. The preliminary results show a strong effect of swirl and of spark location on burning time and cyclic variation. In a high swirl homogeneous mixture field, the burning time is minimum for a mid-radius ignition location. The 10% to 90% mass burning time does not vary appreciably with spark location at the higher swirl levels; the 0 to 10% mass burning time is significantly changed with spark location at the higher swirl rates. The greatest cyclic variation occurs for mid-radius ignition and high swirl; the least variation occurs for mid-radius ignition and medium swirl. 1 ref., 4 figs.

30624 (CICS–CE02997, pp. 31-33) **The exhaust-charged cycle for spark-ignition engines.** Rao, V.K. (Royal Military College of Canada, Kingston, ON (Canada)); Bardon, M.F. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Low ambient temperatures cause difficulty in starting, and a protracted warm-up time in the operation of automotive spark-ignition engines. This problem can be approached by a simple modification to the 4-stroke, spark-ignition engine: the engine is operated at a back pressure higher than the intake pressure by manipulaing the throttle valves in the exhaust and the intake passages. At the end of suction stroke, the cylinder is put in communication with the exhaust system, so that the pressure before the beginning of the compression stroke is raised to the back pressure by an admixture of high-temperature gases from the exhaust system. The thermodynamic cycle of operation of the engine is, thus, somewhat altered; it is referred to as the exhaust-charged (EC) cycle. A theoretical analysis of the EC cycle, both for the motored and firing conditions of operation of the engine has been carried out with the help of a computer program containing a thermodynamic analysis of the gas exchange process; the results of this analysis are presented. It is seen that a significant increase in the charge temperature at the beginning of the compression stroke can be attained with the EC cycle, even when the engine is motored; the amount of heat transferred to the block per cycle is greater than in the conventional engine. On the other hand, mechanical modifications are required, and there is a reduction in the power output from the engine, due to increased pumping losses and reduced volumetric efficiency. In conclusion, the EC cycle offers some advantages for automotive engines that operate under extremely cold ambient temperatures. 4 refs., 5 figs.

30625 (CICS–CE02997, pp. 28-30) **Chemical additives to water-in-diesel fuel emulsion.** Summers, R.J. (Royal Military College of Canada, Kingston, ON (Canada)); Rao, V.K.; Bardon, M.F. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The objectives of this study were to identify water-soluble chemicals that had the potential to promote ignition and assist combustion in a Diesel engine, and to determine experimentally what effects these chemicals have on the performance and emission of a single-cylinder direct injection engine. Suitable oxidizer, additives were chosen on the basis of their water solubility, availability and safety of handling. Aqueous solutions of the following additives were produced: potassium nitrate, hydrogen peroxide, ammonium nitrate, and hydroxylamine nitrate. Amyl nitrate was dissolved directly in number 2 Diesel fuel. Emulsions containing 5 vol % and 10 vol % of each additive in number 2 Diesel fuel were prepared with the help of an emulsifying agent. A Ricardo Hydra, single-cylinder direct injection engine was use to burn the various emulsions. Each emulsion was tested in 2 constant-speed tests (40 and 60 rps); performance data, emissions concentrations and pressure traces were taken during each test. All of the emulsions caused a drop in the brake mean effective pressure achieved at a given fuel/air ratio. The effects on knocking, on smoke, carbon monoxide and hydrocarbons emissions and an ignition delay are presented. It is concluded that the effects of water-soluble additives are minimal and that none of them significantly alters the effects of water addition on ignition and combustion; however, the scope of this work did not include optimization of the injection timing for best power. It is suggested that these additives might be useful for lower-speed engines burning residual fuels. 2 refs., 3 figs.

30626 (CICS–CE02997, pp. 25-27) **An experimental investigation of diesel engine heat release rate and combustion noise.** Sagaleo, P.M. (Kentstate Univ., Kent, OH (USA)); Kumar, S.V.; Pai, V.U. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Abrupt pressure rise was thought to be a major cause of the noise produced by the Diesel engine; however, smoothing the

pressure rise did not produce a significant reduction of the noise, even at the expense of increased fuel consumption. It was then found that almost all of the contribution to the noise spectrum of the cylinder pressure above a frequency of about 700 Hz was due to random pressure flunctuations, and that the coherence between the cylinder pressure and the noise was very high. The experiments performed on a Deutz-Mag FIL-210 single-cylinder, air-cooled direct injection 4-stroke diesel engine indicated that a transverse mode of wave motion of the combustion process actually exists, and is driven by the randomness in the pressure development in the cylinder. Further experiments were made to determine the connection between this wave motion and the random part of the heat release rate. The experiments were performed on a GM series 3-71, 3-cylinder 2-stroke direct injection liquid-cooled Diesel engine; the engine was run at different load and speed conditions, and cylinder pressure and sound pressure measurements were made. The results given for these experiments are the spectrum of average pressure and the average spectrum of cylinder pressure, the spectrum of the average rate of heat release, the coherence function between cylinder pressure and sound pressure, and the coherence function between average rate of heat release and sound pressure. These results indicate a high degree of causality between cylinder pressure and sound pressure, as well as between heat release rate and sound pressure; they also suggest that the noise produced by the Diesel engine is primarily generated in the low-frequency range, under 1500 Hz. 6 figs.

30627 (CICS–CE02997, pp. 19-21) **Simulation of the diesel engine combustion process.** Flanagan, R.C. (Ottawa Univ., Ottawa, ON (Canada)); Xia, Y.Q. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Canadian Diesel fuels in the 1990s are expected to contain an increasing percentage of tar sands components and be of lower quality. Tests conducted with such fuels on the AVGP GM6V53T Diesel engine did not show any significant changes in engine operability, performance or maximum cylinder pressures; however, the fuels did increase cylinder pressure rates during the beginning of combustion by approximately 50% over high-quality Diesel fuel. Such combustion behavior could lead to premature component failure. This paper describes a novel simulation of the combustion process incorporating both fuel parameters and engine operating point. In this simulation, 5 models control the process: fuel injection, ignition delay, fuel-air mixing rate, fuel-air reaction rate, and combustion. The equations defining the ignition delay, the mixing rate and the reaction rate are provided. In the combustion model, rather than using the heating value of the fuel, thermodynamics and chemical equilibria are used. Any combination of hydrocarbon fuels could be used for the calculation; in this simulation, C6H6, C8,H18 and C12H26 are used to simulate the engine test fuels. Excellent correlation with the experimental data was achieved. The results suggest that, for the off-specification fuels, the most promising approach to reducing pressure rates which maintaining engine performance would be by altering injection timing or by dual injection. 1 fig.

30628 (CICS–CE02997, pp. 115-118) **Ignition of two-component liquid fuel droplets.** Bergeron, C.A. (Ottawa Univ., Ottawa, ON (Canada)); Hallett, W.L.H. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The successful application of off-specification fuels, such as those from tar sands, to Diesel engines will require more knowledge of the effects of fuel properties, such as the boiling range and on ignition behaviour. This paper presents preliminary results of a model for the auto-ignition of single droplets of liquid fuels composed of 1 or 2 components of differing boiling point and/or chemical reactivity. A model of the ignition processes for a single droplet was developed, which incorporates the following assumptions: spherical symmetry; negligible reactant consumption prior to ignition; constant transport properties, evaluated at a state defined by 1/3 weighting between the surface of the droplet and its surroundings; use of concentration and velocity fields from the quasi-steady solution for droplet vaporization; and uniform droplet temperature. Experiments were performed using the suspended droplet technique to test the model and fit the reaction constants; 5 pure fuels were used: n-heptane, iso-octane, benzene, n-hexadecane and α-methylnaphthlene. The paper discusses first the results for single-component droplets. For any given temperature, a minimum droplet size is found below which ignition is impossible; the ignition delay time is nearly independent of the droplet diameter, but is a strongly variable function of temperature. For a 2-component fuel droplet, the vapour-phase mass fluxes and concentrations of the components are described by an extension of the quasi-steady vaporization theory. The results of the model as to the vapour mass fraction histories at the liquid/vapour interface and the corresponding ignition delays are presented and discussed in the case of a n-heptane/n-hexadecane mixture. 4 refs., 4 figs.

30629 (CICS–CE02997, pp. 108-110) **The effects of squish-generated turbulence on I.C. [Internal Combuston] engine performance.** Dipmala-Dolesky, R. (Simons Ltd., Vancouver, BC (Canada)); Evans, R.L. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The objective of this work was to gather more experimental data on the effects of squish-generated turbulence in a modern spark ignition engine. The method employed to control the level of turbulence made use of an original design called the squish-jet combustion chamber; this design generates jets in the chamber before the top-dead center, and thus creates very different turbulent flow patterns from a simple squish motion. Natural gas, a fuel that burns slowly, was used for the tests. The project was completed in 3 stages. First, an analytical model of the squish-jet flow was used to optimize the geometry of the patented combustion chamber. Second, a flow visualization experiment was carried out in a plexiglass model, under conditions similar to those of a motored engine. Third, tests were made on a Ricardo Hydra single-cylinder research engine. The engine performance parameters as measured by the signals from a network of transducers, were evaluated with an IMB personal computer. Flow measurements were conducted in the engine while motored by a direct current motor; the measuring technique was constant temperature hot wire anemometry. Performance tests were carried out for 6 different piston configurations chosen from those analyzed in the flow experiments; the analysis of the pressure histories by computer was focussed on peak pressure, indicated mean effective pressure (MEP), and mass fraction burnt. It is stated, without explanation, that the squish-jet design does not create jets strong enough to enhance turbulence very much; however, it produces slower burning rates in the first half of the combustion process and develops lower peak pressures than the simple squish design. The variabilities of both MEP and peak pressure were found to be unaffected by the presence or absence of a strong squish motion. 2 refs., 1 fig.

30630 (CICS–CE02997, pp. 102-105) **Cyclic variations and turbulence structure in a single-cylinder engine.** Kapil, A.K. (British Columbia Univ., Vancouver, BC (Canada)); Hill, P.G. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military

College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Measurements have been made of cylinder pressure in a single cylinder spark-ignition engine over a large number of cycles at various speeds and fuel-air ratios. From these measurements, the peak pressures, burning times and their standard deviations have been determined. The Ricardo Hydra research engine, and the data acquisition and control system used in the experiments, are described. Measurements of cylinder pressure were made at 4 speeds (3000, 3600. 42000 and 4800 rpm); at various equivalence ratios in the lean side of stoichiometry, and with wide-open throttle, 100 cycles of pressure data were recorded for each speed. Consistently with previous experiments, the results show that the magnitude of cyclic variation is quite dependent on equivalence ratio (even in the absence of misfiring) as wel as on trubulence parameters. The results also confirm that the time scale of the fluctuations in the early stages of burning can be estimated from the Tennekes model of small-scale structure of turbulence; with some reservations, it is concluded that the causes of cyclic variation in spark ignition engines lie mainly in the small-scale structure of turbulence. 4 refs., 5 figs.

3303 Electric-Powered Systems

30631 (CONF-900562–4) **Current distribution in cylindrical porous electrodes.** Marshall, S.L. Argonne National Lab., IL (USA). [1990]. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Spring meeting of the Electrochemical Society; Montreal (Canada); 6-11 May 1990. Order Number DE90009707. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A general solution of the equations defining the potential distribution in porous electrodes is derived. Finite conductivity of the metallic matrix is considered. The results are used to determine axially symmetric potential and current distributions in cylindrical porous electrode in cases where current flow is radial. Values of the matrix:electrolyte conductivity ratio for which the limiting case of an infinitely conductive matrix is closely approached are determined. A formula for the area-specific resistance is given, and a procedure for optimizing electrode thickness with respect to transfer current uniformity is described. Deviations from one-dimensional current distribution that result from specification of nonuniform current density at the boundary are considered. 18 refs., 7 figs.

3306 Vehicle Design Factors

Refer also to citation(s) 30839

30632 (AD-A–216673/4/XAB) **Life of concentrated contacts in the mixed-ehd and boundary-film regimes. Final report.** McCool, J.I. MRC Bearings-SKF Aerospace, Jamestown, NY (USA). Aug 1989. 155p. Available from NTIS, PC A08/MF A01.

This analytical and experimental program investigates the influence of surface finish, material and lubricant on rolling contact bearings operating in the low or marginal lubricant film regime. The investigation includes failure analysis of field failures encountered with Helicopter mast support and planetary gear transmission bearings, computer analysis of the above two bearing applications using SKF computer programs SHABERTH and PLANETSYS and testing of specimens made of M50 and 9310 steel using a geared roller tester at NAPC.

3307 Emission Control

Refer also to citation(s) 29981, 30626

30633 Removal of nitric oxide from exhaust gas with cyanuric acid–. Siebers, D.L. (Sandia National Labs., Livermore, CA (USA). Combustion Research Facility); Caton, J.A. *Combustion and Flame (USA),* 79(1): 31-46 (Jan 1990).

Addition of gaseous isocyanic acid (HNCO) to the exhaust of combustion systems or chemical process is proposed as a method for reducing nitric oxide (NO) emissions. The HNCO selectively reduces NO in the exhaust through a multistep chemical reaction mechanism. This article presents an experimental investigation of the proposed NO reduction process using cyanuric acid as the source of HNCO. At elevated temperature cyanuric acid decomposes and forms HNCO. The effects of temperature, exhaust gas composition, cyanuric acid concentration (i.e., HNCO concentration), and surfaces were examined. The experiments were conducted in an electrically heated quartz flow reactor using either exhaust from a diesel engine or simulated exhaust gas. The results demonstrate that gas phase NO reduction approaching 100% can be obtained.

3308 Alternative Fuels

Refer also to citation(s) 29957, 30021, 30184, 30623, 30625, 30628, 30629, 30947

30634 (CICS–CE02997, pp. 37-39) **The performance of an SI [spark ignition] engine using various liquid fuels.** Odgers, J. (Laval Univ., Quebec, PQ (Canada)); Kretschmer, D. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Currently, experimental and theoretical work is being done to investigate the use of alternative fuels in internal combustion engines. In the work described here, an unleaded gasoline was selected as the standard fuel. The other fuels tested were benzene, and a 50-50 methanol-gasoline mixture. The motor used was a single-cylinder, variable compression ratio, ASTM-CFR engine. The temperature and humidity of the air-fuel mixture were controlled prior to its admission into the cylinder. The engine compression ratio was varied from 4 to 10; the spark advance was varied along with the compression ratio according to the ASTM motor method, and rotational speeds of 600 and 900 rpm were used. The CO emissions for the 3 fuels are given as a function of their equivalence ratio; all the fuels show the same form of curve, and the influence of the compression ratio is not noticeable within the accuracy of the data. At the same compression ratio, the amount of hydrocarbons is only slightly influenced by fuel type. Benzene seems to yield the maximum pollution. However, the results indicate a significant influence of compression ratio. For benzene, they suggest that the time to peak pressure may be correlated in terms of the compression ratio to the power 0.7, the combustion efficiency is given as a function of the compression ratio. The decreases in exhaust temperature observed as the compression ratio increases, and as the mixture weakens, are in agreement with theory. The implications of these findings for the development of a quantitative model of engine operation are discussed. Other measurements which have been obtained in this test series bear on nitrogen oxides emission, octane rating engine power, P-V diagrams, P-Z diagrams, and carbon dioxide and oxygen measurements within the exhaust. 1 ref., 6 figs. 3

30635 (CICS–CE02997, pp. 34-36) **Comparison of compression characteristics of an air cooled single cylinder Lister ST1 diesel engine with and without controlled heat losses.** Wong, J.K.S. (National Research Council, Ottawa, ON (Canada)); Smith, R.R. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The studies of the use of hydrogen as fuel in spark ignition and Diesel engines are summarized. Under the most favorable conditions, the minimum temperature of auto-ignition of a hydrogen-air mixture is 844K. The present study involves the investigation of the compression characteristics of a standard diesel engine during motoring with or without controlled heat losses. An Oldsmobile V8 Diesel engine was used to motor an air-cooled single-cylinder Lister ST1 Diesel engine. The non-modified Lister engine was motored at

several pre-selected speeds to obtain its compression characteristics; for the controlled heat loss engine, partially stabilized Zirconia components were mounted on 3 engine parts in order to shield them from the combustion zone. The conclusions are that the compression index increases with engine speed, that the compression index for the controlled heat loss engine is consistently higher than that of the non-modified engine by about 5% at the same engine speed, and that all compression indices are below 1.4, which is the ratio of specific heats for hydrogen-air mixtures. The maximum temperature increases with engine speed; however, the calculated maximum temperature for the modified engine was about 100K below. Takahaski's suggested minimum temperature of 980K for the ignition of hydrogen-air mixtures. In future hydrogen compression ignition investigations, care must be exercised in order to eliminate the compression ignition of lubricating oil. 7 refs., 2 figs.

30636 (CICS–CE02997, pp. 22-24) **Performance and emissions of a propane-fueled diesel engine.** Oester, U. (Toronto Univ., Toronto, ON (Canada)); Wallace, J.S. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The conversion of vehicles to operate on propane contributes to the national goal of reducing the country's dependence on petroleum supplies. The intake of propane is limited to relatively low ratios of propane to Diesel fuel by high rates of pressure rise. Total substitution can be obtained by introducing the propane into the combustion chamber as a liquid spray, just as with Diesel fuel. However, since propane has a very low cetane number, some source of ignition must be provided. This paper reports on an investigation utilizing a continuously operating glow-plug for ignition. The experiments were carried out with a single-cylinder Wowkesha CFR cetane rating engine fueled by injected liquid propane. A Champion CH-78 glow plug was installed in the swirl chamber. Fuel injection system modifications were necessary to handle propane. Tests were carried out at compression ratios of 19:1, 22:1 and 25:1 and at engine speeds of 1200, 1500 and 1800 rpm. Results shown for the compression ratio 22:1 are representative of those obtained at the other operating conditions. The main advantage of liquid propane injection is reduced smoke emission compared to the same engine operating on diesel fuel, and a modest improvement in energy efficiency. The emissions of hydrocarbons and carbon monoxide are less, and those of nitrogen oxides, greater than for diesel fuel operation. Two glow-plug locations have been tried, but additional development work is required. 5 figs.

35 ARMS CONTROL

3501 Policy, Negotiations, and Legislation

Refer also to citation(s) 31335

30637 (AD-A–217269/0/XAB) **Impact of the intermediate-range nuclear forces treaty on Turkey's defense requirements. Research report.** Aycan, C. Air Univ., Maxwell AFB, AL (USA). Air War Coll. May 1989. 55p. Available from NTIS, PC A04/MF A01.

The Intermediate-range Nuclear Forces Treaty which was signed on 8 December 1987 eliminates the intermediate-range of American and Soviet ground based missiles from Europe. The treaty has created differences among NATO allies over NATO's military strategy, the modernization of the western nuclear arsenals and future arms control negotiations. Turkey, one of the NATO countries, shares a 610 kilometers common border with the Soviet Union, and is especially concerned about Intermediate-range Nuclear Forces Treaty's effect on its security. This study will examine the impact of the Intermediate-range Nuclear Forces Treaty on Turkey's defense requirements and attempt to determine what changes in them should be made in the next five years.

30638 (AD-A–217286/4/XAB) **START (Strategic Arms Reductions Talks) - the road to nuclear stability. Research report.** Hansen, B.N. Air Univ., Maxwell AFB, AL (USA). Air War Coll. Mar 1989. 76p. Available from NTIS, PC A05/MF A01.

President Reagan committed the United States to reaching a strategic nuclear arms control agreement that would enhance nuclear deterrence stability between the United States and the Soviet Union. By accepting the premise that nuclear stability had eroded over the last decade, the author discusses the various schools of view for enhancing stability and the various factors that affect the stability of nuclear deterrence. This sets the stage for an evaluation of a START Treaty based upon United States Geneva proposals as to whether or not stability is enhanced by using likely START Treaty constrained force structure. In the author's opinion, the proposed START Treaty provisions are generally neutral to general stability, but the same provisions leave openings for both sides to exploit that would erode crisis stability. Included are recommendations for both unilateral U.S. actions and START Treaty proposals that, if adopted, would lead to increased crisis stability.

3502 Proliferation

Refer also to citation(s) 30176

3503 Verification

30639 (SAND–90-0462) **Seismic signal processing optimized for a specific source and receiver.** Stearns, S.D. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010189. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A seismic signal processing procedure is designed so that its performance is optimized for a specific seismic array looking for explosions at a specific teleseismic location. In this report we first describe the processing procedure, which essentially estimates beamformer signal power as a function of time in a specified frequency band. Then we calibrate the procedure for the Norwegian Regional Seismic array (NRSA) in terms of "equivalent body magnitude" (emb) level versus signal power using US Department of Interior/Geological Survey (USGS) epicenter data from documented explosions at the USSR Semipalatinsk test area in Eastern Kazakh. Finally, we test the performance of the procedure on actual NRSA data and estimate that explosions above approximately mb 4.0 at Semipalatinsk correspond with an event rate in the emb signal on the order of one to ten events per hour. We conclude that, to detect and analyze events around the clock at levels below mb 4.0, an automatic event locator must be used to process the output of the procedure described here. 8 refs., 19 figs., 1 tab.

36 MATERIALS

30640 (PB–90-171612/XAB) **Impact of supercomputing capabilities on US materials science and technology. Final report.** National Academy of Sciences - National Research Council, Washington, DC (USA). National Materials Advisory Board. 1988. 76p. (NAMB–451). Available from NTIS, PC A05/MF A01.

Areas of materials science and engineering are identified where a major impact might be realized as a result of the emergence of supercomputer technology. Supercomputers are emerging as powerful and cost-effective tools, not only for the furtherance of materials science, but also for linking this science with engineering, design, and manufacturing. Conclusions are drawn and recommendations aimed at improving the state of the art of supercomputing for materials science and engineering, especially in those areas where an interdisciplinary approach promises major technological impact.

3601 Metals and Alloys

Refer also to citation(s) 30018, 30100, 30284, 30289, 30298, 30299, 30300, 30301, 30318, 30321, 30323, 30337, 30353, 30354,

30423, 30424, 30425, 30511, 30593, 30596, 30759, 30763, 30765, 30770, 30961, 30973, 30974, 31128, 31314, 31339, 31976, 31978

30641 (AD-A-217387/0/XAB) **Coevaporation and ion implantation of PD50TI50 and PT50TI50 on AISI stainless steels for reducing wear and friction.** Mayer, J.W.; Zheng, L.R.; Hung, L.S. Cornell Univ., Ithaca, NY (USA). Dept. of Materials Science and Engineering. 1 Jan 1989. 6p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Applied Physics, Vol. 65, No. 1, 300-304(1 Jan 1989).

Pd50Ti50 and Pt50Ti50 alloy films were deposited on stainless-steel substrates and irradiated with ion beams. The samples were tested on pin-on-disk wear equipment and analyzed by Rutherford backscattering spectrometry and scanning and transmission electron microscopy. Adding Pd50 Ti50 and Pt50 Ti50 as a surface layer to stainless steel resulted in reduced wear and friction. Xenon implantation slightly improved tribomechanical properties, while Nitrogen implantation led to a dramatic reduction in wear and friction. The improvement was thought to be associated with nitride precipitation hardening and/or forming lubricious during sliding. The as-deposited films exhibited amorphous structures and transformed to equilibrium compounds upon annealing. Sliding tests on amorphous and crystalline films did not show a significant difference in friction and wear behaviour.

30642 (AD-A-217628/7/XAB) **Comment on relaxation-time enhancement in the heavy-fermion system $CePd_3$.** Sievers, A.J. Cornell Univ., Ithaca, NY (USA). 30 Oct 1989. 3p. Available from NTIS, PC A01/MF A01.

Pub. in Physical Review Letters, Vol. 63, No. 18, 2000-2001(30 Oct 1989).

In three recent publications microwave surface-resistance measurements have been reported for CePd3 and UPt3. An approximate formula was used to extract a renormalized scattering time from these data. As shown below this approximation breaks down in the region of interest so that the reported results cannot be identified with a renormalized scattering time.

30643 (CEA-CONF-9954) **High electronic excitations and damage production in GeV ion irradiated metals.** Dunlop, A. (Ecole Polytechnique, 91 - Palaiseau (FR). Lab. CEA des Solides Irradies); Lesueur, D.; Morillo, J.; Dural, J.; Spohr, R.; Vetter, J. Ecole Polytechnique, 91 - Palaiseau (France). Lab. CEA d'Etudes des Solides Irradies. 1989. 18p. (CONF-890821--: 13. international conference on atomic collisions in solids, Aarhus (Denmark), 7-11 Aug 1989). Order Number DE90773408. Available from NTIS (US Sales Only), PC A03/MF A01.

The low temperature damage induced by high energy heavy ions in metallic targets has been followed by in situ electrical resistivity measurements. In Cu_3Au alloys, the observed damage production can be accounted for by elastic collision processes, whereas in Ni_3Fe and iron, inelastic collisions must be put forward above an electronic stopping power threshold. In this last case, collective effects in the wake of the incident ion could explain both (i) the increased damage efficiency and (ii) the inhomogeneous damage distribution that leads to a very small saturation resistivity increase. 17 refs.

30644 (CONF-891119–129) **Grain growth and phase formation in ion irradiated/annealed thin Ni-Al alloys films.** Alexander, D.E. (Michigan Univ., Ann Arbor, MI (USA). Dept. of Nuclear Engineering); Was, G.S.; Rehn, L.E. Argonne National Lab., IL (USA). Jan 1990. 7p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Grant DMR-8603174. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010409. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ion irradiation and annealing studies were performed on Ni, Ni-20 at.%Al multilayers and Ni-20 at.%Al co-evaporated thin films. Xe^+ ions were used to irradiate the films and homogenize the multilayers at room temperature. Irradiation of alloy films formed a metastable, supersaturated solid solution of γ phase and an HCP phase. Ion induced grain growth occurred in all films. A factor of 2 greater growth was observed in Ni–Al multilayers compared with coevaporated films irradiated to the same dose. The enhancement is attributed to a heat of mixing effect. Post irradiation annealing of the mixed multilayers formed γ', the morphology of which was dependent upon the presence of Cu in the films due to substrate mixing from the support grid. 10 refs., 1 fig.

30645 (CONF-891119–130) **Real-time method of powder diffraction for non-periodic and nearly periodic materials.** Egami, T. (Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Materials Science and Engineering); Toby, B.H.; Dmowski, T.W.; Janot, C.; Jorgensen, J.D. Argonne National Lab., IL (USA). Dec 1989. 7p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010537. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The use of high-energy neutrons from pulsed or hot sources allows the method of atomic pair distribution analysis to be applied to the structural determination of crystalline as well as amorphous solids. This method complements the standard crystallographic methods in studying non-periodic aspects of solids with or without long range order. 14 refs., 3 figs.

30646 (CONF-900107–4) **Subsurface hardening and flow of aluminum during the incubation period of solid particle erosion.** Rao, M. (Notre Dame Univ., IN (USA). Dept. of Materials Science and Engineering); Keiser, J.R.; Wilson, D.F. Oak Ridge National Lab., TN (USA). [1990]. 19p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. From 4. Berkeley international conference on erosion-corrosion-wear of materials at elevated temperatures; Berkeley, CA (USA); 31 Jan - 2 feb 1990. Order Number DE90010141. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Samples of annealed 1100 Al were eroded by 600–700 μm spherical steel shot impacting at an angle of 30° to the surface at 45 m/s. The extent of erosion was controlled by varying the dose of solid particle erodent so as to cover the incubation period where the erosion rate is not yet constant. A characteristic ripple structure was observed on the surface with increasing particle dose. The increase of deformation of the subsurface layers was studied using taper-sectioning techniques in conjunction with a mechanical properties microprobe. Distinct differences were observed in the hardness profiles beneath crests and valleys which form the ripple structure. These results are used to discuss material deformation and flow as erosion proceeds. 31 refs., 13 figs.

30647 (CONF-900419–5) **Effect of film adhesion on tribological properties of silver-coated alumina.** Erck, R.A.; Erdemir, A.; Fenske, G.R. Argonne National Lab., IL (USA). Feb 1990. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990. Order Number DE90010090. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Soft metal films are seen as possible solid lubricants for sliding ceramics in high-temperature environments. Ion bombardment of substrate and film can improve film adhesion and tribological properties of metal films deposited on ceramics. To provide a more detailed understanding of the relationship between measured adhesion strength, surface roughness, and wear performance of coatings, thin Ag films were vapor-deposited on smooth and roughened alumina substrates using 1-keV ion bombardment before and during deposition. A pull-type tester was used to measure the adhesion of films to the substrate. A ball-on-flat test machine was used to evaluate the wear of an uncoated alumina ball sliding on silver-coated substrates. Measurements of film adhesion and sliding wear, and an SEM examination of wear tracks, are reported. Ball wear on roughened surfaces was reduced by a factor of ~3 for poorly adhering coatings, but by a factor of ~130 for well-adhering coatings deposited after argon/oxygen sputter-cleaning, compared to bare al_2O_3. For films with the lowest wear, the Ag coating wore off the tips of the asperities, but the film remained almost completely intact. For smooth flats, wear reductions by a factor of ~3 were obtained for well-adherent coatings. 17 refs., 7 figs., 1 tab.

30648 (CONF-900466–11) **A study of the phase decomposition of Fe-Ni-Al-Mo alloys.** Miller, M.K. (Oak Ridge National Lab., TN (USA)); Hetherington, M.G.; Weertman, J.R.; Calderon, H.A. Oak Ridge National Lab., TN (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010143. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The aging of β' NiAl precipitates in ferritic Fe–Ni–Al alloys has been studied by transmission electron microscopy (TEM) and atom-probe field-ion microscopy (APFIM). The addition of Mo alters the lattice parameter of the phases and segregation of Mo to the interface between the matrix and the particles may alter the interfacial energy. The compositions of the matrix, precipitates and interfaces have been measured by TEM and APFIM. The results are compared. 3 refs., 5 figs.

30649 (CONF-900466–12) **Atomic structure of Ag/Ni interfaces.** Gao, Y.; Merkle, K.L. Argonne National Lab., IL (USA). Mar 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010053. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

While in heterophase systems of small lattice parameter differences, misfit dislocations are often formed at the interface, it is not known, whether and in which form, misfit localization occurs when the misfit is very large. The atomic structure of Ag/Ni interfaces (misfit 14%) was studied by high-resolution electron microscopy (HREM). A special technique was developed to prepare interface specimens suitable for HREM observations. Lattice statics calculations, using embedded-atom potentials, were performed to determine the structure and energies of Ag/Ni interfaces. The lowest interfacial energy was found for the cube-on-cube orientation and (111) interfaces. This is in agreement with the experimental observation, that all interfaces are strongly faceted with (111)Ag/(111)Ni facets. Misfit localization was found by HREM and computer simulation. The HREM observations will be compared to images derived from image simulations, based on model structures obtained from embedded atom calculations. 8 refs., 3 figs.

30650 (CONF-900466–17) **High temperature oxidation of Ni_3Al composites.** Tortorelli, P.F.; DeVan, J.H.; McKamey, C.G.; Howell, M. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010145. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

As part of an effort to develop oxidation-resistant metal matrix composites, the influence of reinforcement materials on the oxidation of Ni_3Al was studied. Thermogravimetric measurements and microstructural analyses were used to determine the 800°C oxidation behavior of Ni_3Al and composites based on this material. The presence of fiber (Al_2O_3)- or particle (TiN or TiC)- reinforcement material in the Ni_3Al increased susceptibility to oxidation as measured by the amount of reacted material, rate constants, and/or extent of internal attack. The orientation of fibers with respect to the free surfaces was found to affect the oxidation behavior by providing, in certain cases, reactive paths along the fiber-matrix interface that led to significant internal penetration. The results suggest that the choice of reinforcement material and the method of materials processing will be important considerations in the design of oxidation-resistant Ni_3Al composites. However, ways to minimize the detrimental influence of the reinforcement material on oxidation resistance often conflict with requirements for obtaining attractive mechanical and physical properties of the composite. 13 refs., 6 figs.

30651 (CONF-900466–20) **The measurement of composition during the early stages of the spinodal decomposition of Fe-Cr alloys.** Hertherington, M.G. (Oxford Univ. (UK). Dept. of Materials); Hyde, J.M.; Miller, M.K. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010471. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The properties of many advanced alloys are derived from extremely fine-scale microstructures. This poses interesting questions about the measurement of composition on this scale. The phase separation of model Fe–Cr alloys has been studied with the atom-probe. Statistical techniques have been used to estimate the composition and compare the results with the predictions of linear and non-linear theories of spinodal decomposition and the distributions obtained from Monte-Carlo calculations. 5 refs., 4 figs., 1 tab.

30652 (CONF-900623–5) **Irradiation creep by glide-induced transient absorption.** Brailsford, A.D. (Ford Motor Co., Dearborn, MI (USA)); Coghlan, W.A.; Mansur, L.K. Oak Ridge National Lab., TN (USA). [1990]. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90010718. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Theoretical models for irradiation creep by climb-enabled glide of dislocations generally assume that steady-state profiles are maintained about a dislocation before, during and after the glide event. We show that, in fact, glide is too rapid to maintain steady profiles. The result is that there are significant transients in point defect flux to the dislocation associated with the termination of the glide event. Such transients propel dislocation climb excursions, which may lead to unpinning and to further glide resulting in irradiation creep. We term this new mechanism of irradiation creep glide-induced transient absorption. The solutions to the applicable time dependent diffusion equations are obtained. Calculations are carried out to identify the temperature ranges, materials, and irradiation parameter regimes where the mechanism is expected to be important. One consequence of the phenomenon is that it renders small dispersion hardening centers ineffective in restraining irradiation creep. 18 refs., 12 figs., 2 tabs.

30653 (CONF-8810352–, pp. 85-90) **Preparation of an IIW recommendation for the application of a critical technical assessment to the conception, fabrication and control of welded products to evaluated fitness for purpose.** Costa, G. (Istituto Italiano della Saldatura, Milan (Italy)). ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Application in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

Relevant to a proposed International Institute of Welding recommendation to apply an engineering critical assessment (ECA, Engineering Critical Assessment) to the design, fabrication and inspection of fitness for purpose, the classification and description of metallurgical deviations of materials, inspection criteria for new products, safety aspects and stress analysis methodologies are reviewed.

30654 (CONF-8810352–, pp. 105-113) **The use of copper in energy saving in the field of power generation.** Ceresara, S. (Centro Ricerche, Europa Metalli-LMI SpA, Fornaci di Barga (Italy)); Talini, M. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

The innovative applications of copper which are examined include its use in solar energy storage systems, as well as in alloys and components for future power plants. In particular, an example is given of the use of copper in solar roofs combined with heat pumps. Within the field of nuclear fusion, the application of copper is considered for superconductiong magnet coils, high-temperature alloys for heat exchanger tubing, cavity resonators, free electron laser superconducting films, etc.

30655 (CONF-8810352–, pp. 127-136) **Development of production and control technologies for welded titanium tubes for condensors.** Cumino, G.; Montagna, G.; Livraghi, M.; Tornaghi, F. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

In Italy, welded titanium tubes for condensors are now being produced on a large scale. In order to guarantee maximum product reliability, fabrication technologies are being upgraded. The definition of a set of tolerance limits governing mechanical and chemical characteristics has consented the elimination of post-welding heat treatment and guaranteed optimum toughness and expanding capabilities. The use of new gauges has allowed improvements in the quality of the weld bead and welding speed. This paper reports on destructive and non-destructive tests which were performed on a batch of tubes to verify quality levels and validate fabrication specifications.

30656 (CONF-8810352–, pp. 137-149) **Squeeze casting applied to light alloys: Technological progress.** Atzori, C. (Alluminia SpA, Portoscuso (Italy)); Chinnathambi, K.; Di Russo, E. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy.Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

The squeeze casting process differs form traditional methods in that it allows slow and controllable injection into moulds and the application of high pressures during entire phase of solidification. With suitably modified vertical squeeze casting equipment, tests were conducted on a series of Al-Si and Al-Si-Cu alloys with the aim of determining the maximum achievable levels of structural and mechanical characteristics. The results indicated the possibility of obtaining,through proper alloying, quenching and aging techniques, high levels of mechanical resistance.

30657 (CONF-8810352–, pp. 171-179) **Alternative steels for power plant components.** Arbanelli, M.; Camona, G.; Zannoni, G. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 1920 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper reviews the new steels (i.e. chromium-molybdenum, nickel-chromium, chromium-molybdenum-vanadium steels) being developed for power plant components, in particular - steam turbine rotors, turbine blades, nozzles and fusion reactor cooling systems. Emphasis is given to the review of specifications governing chemical and mechanical characteristics, corrosion and fatigue resistance and, in the case of fusion reactor components, magnetic characteristics.

30658 (CONF-8810352–, pp. 197-217) **Optimization of magnetic properties of electrical steel sheeting: Recent progress and possible improvements.** Barisoni, M. (Centro Sviluppi Materiali, Rome (Italy)); Marini, P.; Priante, M. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

The recently introduced fabrication technologies and the expanded knowledge base in metallurgy have gradually made possible the fabrication of steel sheeting with a reduced inclusion content and improved magnetic characteristics. The magnetic characteristics of commercially available non-orientated grain sheeting, for the most part, exceed established standards and additional improvements can be incorporated to satisfy future market requirements. Within the sector of orientated grain sheeting, a new, super-orientated grain product has been developed whose fabrication technology is highly sophisticated. In the top quality version, laser beam irradiation is utilized to reduce the size of magnetic fields. This paper illustrates the noted relationships between magnetic characteristics and metallurgical variables and presents an overview of the evolution taking place in the fields of orientated and non-orientated sheeting for electrical machinery.

30659 (CONF-8810352–, pp. 221-240) **Thermomechanical processes in forging: State-of-the-art modeling techniques.** Marchi Ricci, F.M. (Centro Sviluppo Materiali, Rome (Italy)); Santafe, C.; Callegari, L. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper deals with current trends in the formulation of finite element mathematical models to describe thermomechanical processes in forging. With the aim of optimizing models to simulate specific phases of materials working, two independent approaches are being taken. The first is directed towards describing the distribution of large plastic deformation within cylindrical bodies as a function of the diverse variables in the forging process. Within this area of study, an integrated model for the prediction of microstructural evolution has been developed. The second approach regards the possibility of predicting the behaviour with time of the internal stresses induced by heat treatments and the consequent viscoelastic range deformations. Relevant to this study area, a practical example is given of an investigation of the thermal stress behaviour of a forging during a thermal treatment cycle.

30660 (CONF-8810352–, pp. 241-254) **9Cr-1Mo-Nb-V-N steel for high temperature applications: Preliminary experience and future applications.** Cumino, G. (Dalmine SpA, Dalmine (Italy)); Leali, C.; Airaghi, P.G.; Bedoni, V. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper describes the modified 9Cr-1Mo steel's material characteristics, intrinsic properties and relevant research programs currently underway in Italy and Europe. A description is given of the experience gained at the Dalmine (Italy)shop in the fabrication of small diameter heat exchanger tubing. The most promising high temperature applications of this steel are cited and a progress report is given on European efforts to establish suitable quality control standards.

30661 (CONF-8810352–, pp. 255-270) **Low carbon sheet steel for offshore applications: Fabrication and performance testing.** Manzoli, T. (Belleli, Mantua (Italy)); Gaggi, G.; Bellei, G.; Montenovi, P.; Rapetti, R. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

This paper describes the fabrication methods and technical characteristics of a low carbon (containing a certain percentage of copper and nickel and micro-alloyed to niobium and with an

extremely reduced impurities content) sheet metal for offshore applications. Emphasis is given to a discussion of weldability criteria and welding tests employed in the development of the this high-tech, highly elastic, low pearlite, steel with a chemical composition that allows good reproduceability, mechanical properties and weldability, as well as excellent lamellar tearing resistance.

30662 (CONF-8810352–, pp. 299-314) **Superaustenitic alloy 28Cr-32Ni-3,5Mo: Fabrication, transformation, and qualification.** Cariboni, L. (Dalmine SpA, Bergamo (Italy)); Ciambotti, A.; Roffin, A. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

In a metallurgical study, conducted on the alloy 28Cr-32Ni-3,5Mo attention is given to hot workability for the optimization of primary and secondary transformation cycles in order to obtain forged rods and tubes for oil industry applications. The forging cycle was defined through a series of industrial tests beginning with several differently sized castings and ingots transformed by diverse thermomechanical cycles. Numerous hot extrusion tests and successive cold workings (drawings, laminations) were performed to the relative best combinations of operating parameters with the main objective of fabricating cold hardened tubes with high, narrow, limits of mechanical resistance, as well as optimum corrosion resistance against high temperature sulphydric fluids, acids and salines.

30663 (CONF-8905310–1) **The effect of trace amounts of antimony on the structure and properties of aluminum alloy A356.2.** Tuttle, B.L. (Tuttle (B.L.) (USA)); Keslinke, A.; Twarog, D.L.; Daniels, E.J. Argonne National Lab., IL (USA). [1989]. 37p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 93. casting congress of the American Foundryman's Society; San Antonio, TX (USA); 9-11 May 1989. Order Number DE90010461. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This investigation was performed to determine the effect of trace amounts of antimony (Sb) on the microstructure, mechanical properties, and casting properties of strontium-modified A356.2 aluminum alloy that was cast in chemically bonded sand molds. The aluminum-silicon alloys were prepared in a high-frequency induction furnace from primary A356.2 ingot of commercial purity. Each melt was grain-refined with aluminum-titanium rod, modified with aluminum-strontium-silicon rod, and degassed with dry nitrogen. Five heats were prepared at each target level of Sb: 0.00, 0.05, 0.10, 0.15 and 0.20 wt %. Significant changes in mechanical and foundry properties resulted from changes in the morphology of the aluminum-silicon eutectic microstructure at the different Sb concentrations. The principle mechanical property affected was elongation (ductility). At an Sb concentration of 0.00%, elongation was 5.3%. At a concentration of 0.06%, elongation decreased to 2.9%. The fluidity of the alloy was also affected. At all three temperatures investigated, fluidity declined approximately 17% at 0.14% Sb relative to alloy containing no Sb. At an Sb content of 0.26%, the fluidity increased approximately 22% (relative to that at 0.14% Sb) to a value slightly higher than that of the Sr-modified alloy containing no Sb. None of the thermal analysis curves for the five levels of Sb addition indicated a cooling curve inflection that could be attributed to the presence of Sb alone. 14 refs., 9 figs., 10 tabs.

30664 (DOE/ER/45057–5) **[Investigations of ultrasonic wave interactions at imperfect boundaries separating anisotropic materials]: Progress report.** Adler, L. Ohio State Univ. Research Foundation, Columbus, OH (USA). Dept. of Welding Engineering. 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45057. Order Number DE90010661. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The main objective of our current research effort is to obtain a better understanding of ultrasonic wave interaction with imperfect interfaces in polycrystalline materials. In accordance with our previous Research Proposal, this effort was focused on five specific areas of particular interest which will be discussed separately. 7 refs.

30665 (DOE/ER/45139–5) **The catalytic reactivity of thin film crystal surfaces: Final technical report, July 1, 1984–December 31, 1989.** Vook, R.W. Syracuse Univ., NY (USA). 1 Mar 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER45139. Order Number DE90010579. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A detailed investigation of the surface reactivity of epitaxial Pd(111) and Cu(111)/Pd(111) thin films was carried out for the CO oxidation reaction to form Co_2. The work involved AES, LEED, W.F., TDS, isothermal desorption spectroscopy, TEM/TED, and high pressure catalytic reactivity investigations. Significant results were obtained regarding (1) the thin film growth modes and the morphology of the overlayers, (2) the isothermal desorption energy of CO from Pd(111) films, (3) CO desorption energies form Pd(111) and Cu(111)/Pd(111) bilayer films, (4) the kinetics of CO and O_2 adsorption on Pd(111) films and for CO on various Cu(111)/Pd(111) thin film bilayers, and (5) the relative CO oxidation rates on Pd(111) and various Cu(111)/Pd(111) bilayer films in the one atmosphere pressure range. The catalysis results were interpreted in terms of weakly adsorbed CO and O_2 molecules and the formation of surface steps when the Cu overlayer thickness exceeded the critical thickness for misfit dislocation formation. These results are important in understanding the nature of the catalytic CO oxidation reaction using thin metal overlayers. It is the first such study of this reaction using metal bilayers, both of which were epitaxial thin films.

30666 (DOE/ID–10282) **Development of a spray-forming process for steel: Semiannual program report for the period ending February 28, 1990.** DuBroff, W. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Key, J.F.; Grant, N.J.; Ando, T.; Kikka, V.K.; Hobson, D.O.; Tszeng, Tszeng-Chuen; Howell, C.R. EG and G Idaho, Inc., Idaho Falls, ID (USA); Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering; Oak Ridge National Lab., TN (USA). 4 Apr 1990. 200p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570;FG07-89ID12855;AC05-84OR21400. Order Number DE90009900. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The principal objective of this program is to develop a near net-shape casting technology based on spray atomization and deposition for the production of low-carbon steel sheet and plate with estimated energy and cost savings of $20/t and $50/t, respectively. The properties produced with this process are generally equivalent or greater than that obtained with conventional continuous or ingot casting practices. Although the effort in this program is currently directed toward flat products, the technology has the flexibility to produce materials in a variety of thicknesses and shapes. Furthermore, enhanced versions of the technology will be able to produce high margin products, such as coated steel, in relatively few operations compared to the current flow sheet. The production of new materials, such as steel-based composites, is also possible with this technology. The combination of enhanced properties, new materials, and shaped products distinguishes the spray forming technology from all other near net-shape casting processes. 47 refs., 67 figs., 7 tabs.

30667 (FRCEA-TH–256) **Contribution to mechanical and crystallographic analysis of molyledenum layers prepared by magnetron cathode sputtering.** Bosland, P. Institut National Polytechnique, 38 - Grenoble (France); CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Metallurgie. 1988. 183p. (In French). Order Number DE90784613. Available from NTIS (US Sales Only), PC A09/MF A01.

Molybdenum coatings presenting different compression stresses are elaborated by magnetron cathode sputtering by varying the negative voltage of the substrate during deposition. Stress evolution is accompanied by crystal texture evolution and argon content incorporated in the layers. Crystallite orientation is explained by a phenomenon similar to canalisation observed in ion implantation. In a same deposit each component presents its own deformations different from neighbouring components.

30668 (Juel–2303) **Crack growth under combined creep and fatigue conditions in alloy 800.** Pfaffelhuber, M.; Roedig, M.; Schubert, F.; Nickel, H. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Technische Hochschule Aachen (Germany, F.R.). Aug 1989. 146p. (In German). Order Number DE90784860. Available from NTIS (US Sales Only), PC A07/MF A01.

Dissertation submitted by M. Pfaffelhuber.

To investigate the crack growth behaviour under combined creep-fatigue loading, CT 25 mm-specimens of X10NiCrAlTi 32 20 (Alloy 800) have been tested in experiments with cyclic loadings and hold times, with static loadings and short stress rekief interrupts, with ramp type loadings and with sequences of separate fatigue and creep crack growth periods. The test temperature of 700deg C was selected because only in this temperature range this alloy provides similar amounts of crack growth under creep and fatigue conditions due to equivalent stress levels. For the estimation of crack growth under combined loading conditions a linear accumulation of increase in crack length was proved using the crack growth laws of pure creep and fatigue crack growth. Hold time and ramp loadings lead to a higher crack growth rate compared with pure creep or pure fatigue crack growth tests. In hold time experiments the crack growth rate is higher than ramp tests of the same period time. The results of hold time tests can be fairly enough predicted by linear damage accumulation rules. (orig.).

30669 (Juel-Conf–76) **High temperature corrosion of metals. Proceedings.** Quadakkers, W.J.; Schuster, H.; Ennis, P.J. (eds.). Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Reaktorwerkstoffe. Aug 1988. 353p. (CONF-8712165–: 2. workshop of German and Polish research on high temperature corrosion of metals, Juelich (Germany, F.R.), 2-4 Dec 1987). Order Number DE90784758. Available from NTIS (US Sales Only), PC A16/MF A01.

This paper covers three main topics: 1. high temperature oxidation of metals and alloys, 2. corrosion in sulfur containing environments and 3. structural changes caused by corrosion. The following 21 subjects are discussed: Influence of implanted yttrium and lanthanum on the oxidation behaviour of beta-NiA1; influence of reactive elements on the adherence and protective properties of alumina scales; problems related to the application of very fine markers in studying the mechanism of thin scale formation; oxidation behaviour of chromia forming Co-Cr-Al alloys with or without reactive element additions; growth and properties of chromia-scales on high-temperature alloys; quantification of the depletion zone in high temperature alloys after oxidation in process gas; effects of HC1 and of N2 in the oxidation of Fe-20Cr; investigation under nuclear safety aspects of Zircaloy-4 oxidation kinetics at high temperatures in air; on the sulfide corrosion of metallic materials; high temperature sulfide corrosion of Mn, Nb and Nb-Si alloys; corrosion behaviour or NiCrAl-based alloys in air and air-SO2 gas mixtures; sulfidation of cobalt at high temperatures; preoxidation for sulfidation protection; fireside corrosion and application of additives in electric utility boilers; transport properties of scales with complex defect structures; observations of whiskers and pyramids during high temperature corrosion of iron in SO2; corrosion and creep of alloy 800H under simulated coal gasification conditions; microstructural changes of HK 40 cast alloy caused by exploitation in tubes in steam reformer installation; microstructural changes during exposure in corrosive environments and their effect on mechanical properties; coatings against carburization; mathematical modeling of carbon diffusion and carbide precipitation in Ni-Cr-based alloys. (MM).

30670 (KFK–4669) **Investigations on cyclic thermal fatigue of 1.4436 austenitic steel tubes.** Neumann, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Maschinenbau. Dec 1989. 166p. (In German). Order Number DE90784894. Available from NTIS (US Sales Only), PC A08/MF A01.

Results of crack initiation and crack propagation in 1.4436 austenitic steel tubes under cyclic thermal loading are presented. From outside the tubes are induction heated rotation symmetrically, the interior is cooled by water. Crack initiation and propagation on the inner surface is investigated with an endoscope in fixed intervalls. The crack distribution is evaluated statistically. The temperature distribution in the wall is calculated analytically and allowed further calculations of elastic and inelastic stress-strain-distributions. Crack propagation is described with the methods of fracture mechanics (K-Concept, J-Integral). Results of lifetime and crack initiation from isothermal uniaxial fatigue tests are compared with the results from the thermal fatigue tests. (orig.).

30671 (LA-UR–90-1439) **Phase stability in the $Al_{(6-x)}Cu_xZr_2$ system for $0 < x < 1.0$.** Desch, P.B.; Schwarz, R.B.; Nash, P. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900466–21: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010620. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have determined the structures and thermal stability of $Al_{(6-x)}Cu_xZr_2 (0 < x < 1)$ powders prepared by mechanically alloying elemental powder mixtures. In the as mechanically alloyed condition the structure is Ll_2 for all x. After heating to 750°C the alloy is single phase DO_{23} for $0 < x < 0.6$, and remains in the Ll_2 phase for $0.6 < x < 1$. Al_5CuZr_2 is stable in the Ll_2 structure up to 1300°C. The lattice parameter of the annealed Ll_2 phase is independent of x. 11 refs., 6 figs.

30672 (NUREG/CP–0104, pp. 2.11-2.12) **Embrittlement of the Shippingport reactor shield tank.** Chopra, O.K. (Argonne National Lab., IL (USA)); Shack, W.J. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Surveillance specimens from the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory showed an unexpectedly high degree of embrittlement relative to the data obtained on similar materials in Materials Testing Reactors (MTRs). The results suggest a possible negative flux effect and raise the issue of embrittlement of the pressure vessel support structures of commercial light water reactors. To help resolve this issues, a program was initiated to characterize the irradiation embrittlement of the neutron shield tank (NST) from the decommissioned Shippingport reactor. The Shippingport NST operated at 55°C (130°F) and was fabricated from A212 Grade B steel, similar to the vessel material in HFIR. The inner wall of the NST was exposed to a total maximum fluence of $\sim 6 \times 10^{17}$ n/cm^2 ($E > 1$ MeV) over a life of 9.25 effective full power years. This corresponds to a fast flux of 2.1×10^9 n/cm^2 $\times$ s and is comparable to the conditions for the HFIR surveillance specimens. The results indicate that irradiation increases the 15 ft $\times$ lb Charpy transition temperature (CTT) by ~25°C (45°F) and decreases the upper shelf energy. The shift in CTT is not as severe as that observed in the HFIR surveillance specimens and is consistent with that expected from the MTR data base. However, the actual value of CTT is high, and the toughness at service temperature is low, even when compared with the HFIR data. The increase in yield stress is ~50 MPa, which is comparable to the HFIR data. The results also indicate a lower impact strength and higher transition temperature for the TL orientation than that for the LT orientation. Some effects of the location across the thickness of the wall are also observed for the LT specimens; CTT is slightly greater for the specimens from the inner region of the wall.

30673 (NUREG/CP–0104, pp. 2.3-2.4) **Heavy-section steel irradiation program summary.** Corwin, W.R. (Oak Ridge National Lab., TN (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. DOE Contract AC05-84OR21400. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

Maintaining the integrity of the reactor pressure vessel (RPV) in a light-water-cooled nuclear power plant is crucial in preventing and controlling severe accidents which have the potential for major

contamination release. The RPV is the only major safety-related component of the plant for which a duplicate or redundant backup system does not exist. For this reason, the Heavy-Section Steel Irradiation (HSSI) program has been established with its primary goal to provide a thorough, quantitative assessment of the effects of neutron irradiation on the material behavior, and in particular the fracture toughness properties, of typical pressure vessel steels as they relate to light-water reactor pressure-vessel integrity. The program includes the direct continuation of irradiation studies previously conducted within the Heavy-Section Steel Technology program augmented by enhanced examinations of the accompanying microstructural changes. Effects of specimen size, material chemistry, product form and microstructure, irradiation fluence, flux, temperature and spectrum, and post-irradiation annealing are being examined on a wide range of fracture properties. The principal materials examined within the HSSI Program are high-copper welds since their post-irradiation properties are most frequently limiting in the continued safe operation of commercial RPVs. In addition, a limited effort will focus on stainless steel weld overlay cladding, typical of that used on the inner surface of RPVs, since its post-irradiation fracture properties have the potential for strongly affecting the extension of small surface flaws during overcooling transients.

30674 (NUREG/CP–0104, pp. 4.7-4.8) **Cast stainless steel aging: Mechanisms and predictions.** Chopra, O.K. (Argonne National Lab., IL (USA)); Chung, H.M. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Oct 1989. (CONF-8910222–Summs.: 17. water reactor safety information meeting, Rockville, MD (USA), 23-25 Oct 1989). In *Transactions of the seventeenth water reactor safety information meeting.* Order Number DE90000746. Available from NTIS, PC A09/MF A01.

A program is being conducted to investigate the significance of low-temperature embrittlement of cast duplex stainless steels under LWR operating conditions and to evaluate possible remedies to the embrittlement problem for existing and future plants. The scope of the investigation includes the following goals: (1) establish the mechanism of embrittlement and validate the simulation of in-reactor degradation by accelerated aging, (2) evaluate the effects of key compositional and metallurgical variables on embrittlement, and (3) obtain fracture toughness data to predict the degree of toughness loss suffered by cast stainless steel components during normal and extended service life of reactors. Charpy-impact, tensile, and J-R curve tests were conducted on several experimental and commercial heats of cast stainless steel that were thermally aged up to 30,000 h at temperatures between 290 and 450°C (~555 and 840°F). The results indicate that aging at these temperatures leads to an increase in tensile strength, a decrease in impact energy, J_{IC}, and tearing modulus of the material, and the ductile-to-brittle transition curve shifts to higher temperatures. In general, the low-carbon CF-3 grades of cast stainless steels are the most resistant and molybdenum-containing high-carbon CF-8M grades are the most susceptible to low-temperature embrittlement. The effects of material variables on the embrittlement of cast stainless steels are evaluated. The ferrite morphology has a strong effect on the degree or extent of embrittlement, while material composition influences the kinetics of embrittlement. The kinetics of embrittlement can vary significantly with small changes in the constituent elements of the cast material.

30675 (ORNL/FTR–3601) **[Irradiation assisted stress corrosion cracking]: Foreign trip report, April 7, 1990–April 14, 1990.** Bell, G.E.C. Oak Ridge National Lab., TN (USA). 30 Apr 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010629. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the ICG-IASCC and presented recent results from electrochemical experiments on prime candidate alloy (PCA) irradiated in FFTF/MOTA. The traveler's results, as well as those of others, illustrated the importance of irradiation-produced microstructures, aqueous radiation chemistry, and mechanical loading conditions in understanding irradiation assisted stress corrosion cracking (IASCC). The traveler also visited facilities at JAERI and discussed areas for future collaboration on fusion reactor materials. Plans for a three-month assignment of the traveler to JAERI in Tokai-mura were discussed.

30676 (PB–90-177015/XAB) **Laser-assisted cladding of refractory materials. Final report.** Creehan, R.D. Physical Sciences, Inc., Andover, MA (USA). Oct 1987. 39p. (PSI–2030/TR-727). Available from NTIS, PC A03/MF A01.

The objective of this study is to establish the feasibility of using high-power lasers in a novel thermomechanical process for cladding of high-melting substrate alloys without producing excessive melting or thermal damage to the underlying substrate or cladding foil. By heating the interface of the clad material and substrate alloy to the eutectic temperature of the binary alloy, a superior metallurgical bond is produced with minimal melting and heating. With the process, only a very narrow region of the clad-substrate interface is actually fused and the clad surface retains a smooth texture which does not require subsequent machining. The coverage rates which can be obtained with the process are one to two orders of magnitude higher than reported in the literature for laser-assisted fusion-cladding processes in which the entire clad layer is fused.

30677 (PB–90-860560/XAB) **Sputter coating of tantalum and tantalum compounds. May 1977-November 1989 (A Bibliography from the COMPENDEX data base). Report for May 1977-November 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 51p. Available from NTISPC N01/MF N01.

Supersedes PB–87-858015.

This bibliography contains citations concerning the properties of tantalum and tantalum compound films formed by sputtering techniques. Topics include processes, and electrical, magnetic, and dielectric properties of the sputtered films. Tantalum compounds studied include nitrates, oxides, and aluminides. The structural properties of sputtered films are also discussed. (This updated bibliography contains 96 citations, 19 of which are new entries to the previous edition.)

30678 (PB–90-862426/XAB) **Corrosion-resistant coatings. June 1983-May 1988 (A Bibliography from the COMPENDEX data base). Report for June 1983-May 1988.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 156p. Available from NTISPC N01/MF N01.

See also PB–90-862434.

This bibliography contains citations concerning the anticorrosive behavior of protective coatings based on such materials as ceramics, metals, and polymers. Topics include high- and low-temperature corrosion, surface structure, mechanical and chemical properties, applications, and performance evaluations. Paints and powder coatings, and methods of application are also considered. Protective coatings for specific applications such as gas turbines, coal gasification, power plants, papermaking, carbon steels, reinforced concrete, pipelines, antifouling coatings, and conversion coatings are examined in separate bibliographies. (This updated bibliography contains 348 citations, none of which are new entries to the previous edition.)

30679 (PB–90-862434/XAB) **Corrosion-resistant coatings. June 1988-January 1990 (a Bibliography from the COMPENDEX data base). Report for June 1988-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 117p. Available from NTISPC N01/MF N01.

Supersedes PB–88-863758. See also PB–90-862426.

This bibliography contains citations concerning the anticorrosive behavior of protective coatings based on such materials as ceramics, metals, and polymers. Topics include high- and low-temperature corrosion, surface structure, mechanical and chemical properties, applications, and performance evaluations. Paints and powder coatings, and methods of application are also considered. Protective coatings for specific applications such as gas turbines, coal gasification, power plants, papermaking, carbon steels, reinforced concrete, pipelines, antifouling coatings, and conversion coatings are examined in separate bibliographies. (This updated bibliography contains 227 citations, all of which are new entries to the previous edition.)

30680 (SAND–90-0153) **A vectorized elastic/plastic power law hardening material model including Luaders strain.** Stone, C.M. (Sandia National Labs., Albuquerque, NM (USA)); Wellman, G. W.; Krieg, R.D. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010172. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An elastic/plastic material model has been developed for use with the suite of Sandia Engineering Analysis Department finite element codes. This model describes post-yield strain hardening by a power law equation involving the equivalent plastic strain and includes a yield plateau or Luaders strain region. This combination of power law hardening and Luaders strain accurately represents the mechanical behavior of a large number of commonly used engineering materials. The material model is vectorized to take advantage of current super-computer architecture. The model shows only a modest increase in CPU time over the linear hardening material model currently in the codes. Several example problems are presented to show the accuracy and flexibility of the elastic/plastic power law hardening model. 12 refs., 10 figs., 3 tabs.

30681 (UCRL-JC–103609) **Electronic structure and phase stability properties of Al-Li alloys.** Gonis, A. (Lawrence Livermore National Lab., CA (USA)); Turchi, P.E.A.; Sluiter, M.; Pinski, F.J.; Johnson, D.D. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900466–27: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010632. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recently, the phase diagram of Al–Li alloys was calculated with the use of the Connolly-Williams method. In an effort to test the validity and to supplement the results of that study, equilibrium lattice constants and effective cluster interactions have been obtained using the generalized perturbation method within the first-principles multiple-scattering formalism of the Korringa-Kohn-Rostoker coherent-potential approximation. The implication of these effective interactions to the phase stability of these alloys is discussed. 15 refs., 4 figs.

30682 (UCRL-JC–103610) **A first principles examination of phase stability in FCC-based ordered Ni-V alloys.** Mikolopas, J.; Turchi, P.E.A.; Sluiter, M.; Sterne, P.A. Lawrence Livermore National Lab., CA (USA). 18 Apr 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–26: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010635. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The phase stability of fcc-based ordered Ni-V alloys is investigated using linear muffin-tin orbitals total energy (LMTO) calculations. The method of Connolly and Williams (CWM) is used to extract many body interactions from the ground state energies of selected ordered configurations. These interactions are used in conjunction with cluster variation method (CVM) to calculate the alloy phase diagram. The dependence of the interactions on the choice of configurations used to calculate them is examined. 11 refs. 2 figs., 4 tabs.

30683 Advances in dynamic analysis of plates and shells - 1988. PVP-Vol. 149. Chung, H. (Argonne National Lab., Argonne, IL (US)). 38p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-8806219–: Advances in dynamic analysis of plates and shells, Pittsburgh, PA (USA), 19-23 Jun 1988).

This book contains the papers presented at the conference held in Pittsburgh, on the subject of pressure vessels and piping. Topics discussed were: buckling of imperfect panels under temperature variations; scattering of flexural waves by a crack in a plate; creep stability and failure of plates; and creep and viscoelastic stability of plateplate structures.

30684 Science and technology of rapidly quenched alloys. Materials Research Society symposia proceedings. Volume 80. Tenhover, M. (Standard Oil, Solon, OH (US)); Johnson, W.L.; Tanner, L.E. 462p. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

These proceedings contain 55 papers grouped under the headings of: Formation and properties of amorphous metals, Rapidly quenched microcrystalline alloys, Magnetic properties of rapidly quenched alloys.

30685 A first-principles calculation of the resistivity and thermopwer in strong-scattering alloys. Brown, R.H. (Dept. of Physics, Luther College, Decorah, IA (US)); Allen, P.B.; Nicholson, D.M.; Butler, W.H. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC02-76CH00016. Grant DMR84-20708. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The authors investigate the concentration and short-range order dependence of the zero-temperature resistivity and thermopower for substitutionally disordered alloys from a first-principles approach. The alloy disorder is simulated by calculating the electronic structure of a large supercell (typically 200-250 atoms) with periodic boundary conditions. For the strong-scattering alloys the authors consider, the electron mean-free path is much less than the supercell dimension, causing artificial effects of periodicity to be negligible. In spite of strong scattering, there is no evidence for localized states near E_F. The resistivity and thermopower are averaged over several configurations resulting in statistical error bounds of $\sim \pm 10$ percent. The concentration-dependent resistivity of substitutional $V_{1-x}Al_x$ alloys agree well with Korringa-Kohn-Rostoker coherent potential approximation (KKR CPA) calculations. This confirms the accuracy of KKR CPA theory.

30686 Stacking sequence changes in A_3B-type close-packed structures: A one-dimensional stacking model. . Pei, S. (Dept. of Physics, and Metallurgical Engineering and Materials Science, Carnegie Mellon Univ., Pittsburgh, PA (US)); Massalski, T.B. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Structural modifications resulting from changes in the sequence of stacking of close-packed layers are very common in A_3B- type transition-metal alloys. In the present work, a one- dimensional model of stacking has been explored. The authors find that the stacking changes observed in these alloys can be interpreted in terms of interactions between a few adjacent layers.

30687 AB initio calculations of ordered intermetallic phase equilibria. Sluiter, M. (Univ. of California, Dept. of Materials Science, Berkeley, CA (US)); DeFontaine, D.; Quo, X.Q.; Freeman, A.J.; Podloucky, R. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). Grant DMR-85-18607. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

General procedures for computing alloy phase equilibria from ab initio electronic structure calculations are reviewed and applied to the Al-Li phase diagram. Free energies were calculated by the cluster variation method (CVM) in the tetrahedron approximation for the fcc and bcc lattices and ordered superstructures. Input was provided by first principles FLAPW calculations. The computed phase diagram for both stable and metastable structures agrees well with the experimental one.

30688 Study of the structure and energy of grain boundaries using an LMTO based tight-binding method. Oh, Y. (Dept. of Materials Science and Engineering, Univ. of Pennsylvania, Philadelphia, PA (US)); Vitek, V. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

A parametrized tight-binding (TB) method based on TB-LMTO approach in the atomic sphere approximation (ASA) [26] has been

developed. The Hamiltonian is written in terms of the canonical structure matrix and potential parameters. The former is for a given configuration of atoms evaluated using a Dyson-type equation and the latter are those found self-consistently for the ideal lattice. A warping correction has been added to the scheme to be able to account for the effects of local straining which can not be included in the ASA. This is essential for applications in defect studies. Using this method the structure and energy of the $\Sigma = 5$ [001] twist boundary in cooper has been calculated.

30689 Computer simulation of elastic properties of grain materials. Lutsko, J.F. (Argonne National Lab., IL (USA). Materials Science and Technology Div.). pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

Lattice statics and lattice dyanamics computer simulation methods are applied to investigate the elastic properties of grain boundaries in fcc metals. The elastic constrants in the GB reigon are found to differ significantly from their bulk ideal-crystal values. Due to the broken symmetry in the GB region a pronounced anisotropy of the elastic properties is observed. Whereas Young's moduli are found to increase in the GB region, the shear moduli and Poisson's ratios generally decrease. The magnitude of these effecrs is shown to depend sensitively on the GB structure.

30690 Deformation-induced amorphization of crystalline particles in a Cu-Ti metallic glass. Kamentzky, E.A. (Lawrence Berkeley Lab., CA (USA)); Askenazy, P.D.; Johnson, W.L.; Tanner, L.E. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). DOE Contract FG03-86ER45242. (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

Crystalline particles and grains embedded in $Cu_{35}Ti_{65}$ glass ribbons have been amorphized by isothermal cold rolling. The structural evolution has been studied by X-ray diffraction and TEM techniques. Initial particle morphologies are spherulitic and spherical, the latter with sizes ranging between 10 and 100 nm. The new amorphous phase seems to nucleate at crystalline-amorphous matrix interfaces. Initially there is a well defined interface between the new and the existing amorphous phases but it disappears as rolling progresses. Crystallites on a nanoscale still present in the final stages of particle amorphization have been observed by convergent beam electron diffraction. After sufficient deformation the consolidated ribbon becomes a completely glassy. A morphological description of the transformation process in terms of crystal destabilization and solid- state particle melting is presented.

30691 First-principles theory of alloy phase diagrams. Zunger, A. (Solar Energy Research Institute, Golden, CO (US)); Ferreira, L.G.; Wei, S.H. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC02-77CH00178. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

Temperature-composition phase diagrams of alloys are calculated by a new method combining first principles total energy calculations (at T=0) for ordered structures, using the local density formalism, with finite-temperature statistical-mechanics approach (the cluster variation method) to the solution of the multi-spin Ising model, using volume- dependent interaction energies. Novel features, including the appearance of metastable long-range ordered compounds at low temperatures, are found.

30692 Deformation twinning in ordered intermetallic compounds. Yoo, M.H. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Fu, C.L.; Lee, J.K. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Mechanistic understanding of deformation twinning in ordered superlattice structues is reviewed, and the inter-relationships between twinning and generalized plastic flow or fracture toughness are discussed. While general discussions refer to all the fcc-based and bcc-based cubic and noncubic ordered intermatallic alloys, specific calculations of the energetic and kinetic aspects of deformation twinning are made for TiAl. The importance of the twin-slip conjugate relationship on high temperature mechanical properties is emphasized. Discussion is given of possible effects of macro- and micro-alloying on twinning propensity.

30693 The microchemistry of grain boundaries in Ni_3Al. Sieloff, D.N. (Dept. of Materials Science and Engineering, Univ. of Pittsburgh, PA (US)); Brenner, S.S.; Jian, H.M. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports grain boundary regions B-doped as well as B-free Ni_3Al studied by field-ion microscopy and atom probe microanalysis. In the ductile, recrystalized, Ni-rich alloys the segregaton of boron was often accompanied by an enrichment of nickle. Such an enrichment was not observed at boundaries in B-free alloys. Boron was also observed to segregate to the boundaries in 25.2Al – IB alloy which was reported to contain boron clusters. Such clusters were not observed, instead a high concentration of boron pairs were found.

30694 Theoretical studies of Ni_3Al and NiAl with impurities. Chen, S.P. (Los Alamos National Lab, Los Alamos, NM (US)); Voter, A.F.; Boring, A.M.; Albers, R.C.; Hay, P.J. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Intermatallic compounds have been extensively studied because of their superior strength, low creep rate, and high melting point. However, room temperature ductility for the $L1_2$ and B2 phases are a continuing problem. Both $L1_2$ and Ni_3Al and B2 NiAl exhibit an intergranular fracture mode. Understanding grain boundaries in these materials is of particular importance since intergranular fracture limits the applicability of these otherwise promising materials. In an effort to understand the fracture mechanism, the authors have used embedded atom potentials to sutdy the properties of Ni_3Al and NiAl. They also consider the effect of boron, sulfur, and nickel segregation on the strength of grain boundaries in Ni_3Al and NiAl.

30695 Statics and dynamics of grain boundaries in Ni_3Al. Farkas, D. (Dept. of Materials Engineering, Virginia Polytechnic Institute and State Univ., Blacksburg, VA (US)). pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Various modeling techniques have been used to study the structure of grain boundaries in ordered compounds, particularly Ni_3Al. The techniques include computer simulation, group theoretical analysis and the cluster variation method for high temperature effects. A multiplicity of possible grain boundary structures was analyzed for different misorientations and grain boundary plane location. The influence of several alloy properties like atomic size differences and deviation from stochiometry on the occurrence of these different structures is analyzed. The implications of these results for grain boundary misorientation distribution, grain boundary plane location and faceting behavior are discussed and compared to experimental findings. The possibility of order-disorder transitions in the grain boundary region is also discussed.

30696 Effect of ordering energy on grain boundary structure in $L1_2$ alloys. Ackland, G.J. (Dept. of Materials Science and Engineering, Univ. of Pennsylvania, Philadelphia, PA (US)); Vitek, V. pp. 775 of High-temperature ordered intermetallic alloys III. Liu,

C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Atomic structures of grain boundaries in two $L1_2$ ordered alloys with very different ordering energies have been calculated. The interatomic forces are represented by many-body empirical potentials based on the second moment approximation to the tight-binding density of states. Grain boundaries in strongly ordered alloys show very little relaxation. This results in the presence of columns of cavities in the boundaries. On the other hand, boundaries in weakly ordered alloys, and also in pure f.c.c. materials, show extensive relaxations leading to much more homogeneous structures. The authors suggest that these structural features may be responsive for the intrinsic brittleness of grain boundaries in compounds such as Ni_3Al in contrast with boundaries in pure f.c.c. metals or ordered alloys such as Cu_3Au which are only embrittled by segregation.

30697 Gold-nickel multilayer films: Structure-property correlations. . Nutt, S.R. (Brown Univ., Box D, Providence, RI (US)); Green, K.A.; Baker, S.P.; Nix, W.D.; Jankowski, A. pp. 402 of Thin films: Stresses and mechanical properties. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811222–: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

This paper reports a study in which gold-nickel multilayer films with periods of 1.2 - 4.6 nm were deposited on silicon substrates by magnetron sputtering, and plan and cross- sectional specimens were examined by transmission electron microscopy. The cross-sectional specimens revealed well- defined layering and columnar growth features that extended through the film thickness. Dark striations extending normal to the layers were attributed to diffraction contrast from defect strain fields. Diffraction patterns showed that the films were highly textured and that short-period films had a single fcc structure, while long-period films separated into three fcc structures. High-resolution images of the layer interfaces showed local regions of epitaxy partitioned by regions of disorder. Indentation tests using a Nanoindenter, a depth-sensing indentation device, were performed to measure the elastic modulus and hardness of the films. No modulus enhancement was detected, and a small variation in hardness was measured.

30698 Effects of microadditions of cerium on annealing embrittlement in FeBSi glasses. Kroeger, D.M. (Oak Ridge National Lab., TN (USA). Metals and Ceramics Div.); McKamey, C.G.; Scarbrough, J.O. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). DOE Contract AC05-84OR21400. (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

Microadditions of cerium retard annealing embrittlement in some but not all metallic glass compositions in the FeBSi system. Effects on embrittlement of doping with both cerium and oxygen have been determined for a series of compositions, $Fe_xB_{13}Si_{87-x}$. For $X \gtrsim 80$, cerium retards annealing embrittlement and oxygen promotes it,suggesting that the beneficial effect of cerium additions results from gettering of impurities. The results indicate that for those compositions in the FeBSi system with the highest values of the saturation magnetization, M_S, microadditions of cerium can prevent annealing embrittlement until the onset of crystallization.

30699 Room temperature tensile ductility in polycrystalline B2 NiAl. Vedula, K. (Dept. of Materials Science and Engineering, Case Western Reserve Univ., Cleveland, OH (US)); Hahn, K.H.; Boulogne, B. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports on binary polycrystalline alloys of B2 NiAl, ranging from 47 to 5l.5 at % Al, prepared by casting and extrusion. These were tested in tension at temperatures ranging from 300 K to 873 K. Significant tensile ductility is observed in the near-stoichiometric alloy at room temperature as well as at 473 K in spite of the presence of only <100> disclocations. This anamoly appears to be related to the recrystallized texture, to the lower yield strength and to the presence of residual dislocations at grain bondaries in this alloy.

30700 Creep-fatigue resistance of a nickel-aluminide. Tien, J.K. (Center for Strategic Materials, Henry Krumb School of Mines, Columbia Univ., New York, NY (US)); Bellows, R.S. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper reports a modified fatigue test matrix that provided both creep (high mean stress) and fatigue (alternating stress) damage used to evaluate the creep-fatigue behavior of D.S $Ni_3Al(B,Hf)$. The three generic regimes of below, at, and above peak yield strength temperature were investigated. It was found that the creep-fatigue resistance of this intermatallic remains high through the three temperature regimes, allowing it to be further considered as a monolith or as the matrix of high-temperature fiber reinforced composite.

30701 Deformation and defects in Laves phases. Livingston, J.D. (General Electric Co., Corporate Research and Development, Schenectady, NY (US)); Hall, E.L.; Koch, E.F. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

This paper presents frototype Laves phases $MgCu_2$ and $MgZn_z$ deformed in compression at various temperatures and strain rates, and dislocations produced by deformation characterized by TEM. Ternary cubic laves phases $Mg(Cu,M)_2$, were M-Al, Ni, Si, and Zn, have also been deformed, and substantial solution hardening was observed.

30702 A TEM study of the relationship between dislocation structure and the anomalous temperature dependence of the flow stress in ordered Ni_3Al,1%Ta. Mills, M.J. (Institut de Genie Atomique, Ecole Polytechnique Federale, 1015 Lausanne (CN)); Baluc, N.; Karnthaler, H.P. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The anomalous increase in the yield strength of single crystals of Ni_3Al(l%Ta) as a function of temperature has been correlated with the post-deformation substructure using weak beam TEM techniques. At low temperatures (77K), there is evidence for abundant cross-slip. With increasing temperature, this conventional cross-slip process is gradually replaced by the formation of KW locks–straight screw segments which have cross-slipped and completely dissociated on (010). This change in the mode of cross slip corresponds with the onset of the yield strength anomoly. At still higher temperatures (554K and 715K), the KW locks become mobile and bow out on (010). The density of dislocations on the cube plane also increases sharply at higher temperatures, even though deformation occurs principally by glide on the primary (111) based on slip trace analysis. These observatons are inconsistent with the widely accepted cross slip pinning model and suggest that deformation occurs primiarialy by the motion of the non-screw components. A dislocation model is introduced which attempts to account for the observed dislocation configurations while remaining consistent with the yeild strength and work hardening behavior of these alloys.

30703 Compression deformation structures of single crystal TiA1. Huang, B.Y. (Powder Metallurgy Institute, South Central Univ. of Technology, Changsha, Huuan (CN)); Oliver, B.F.; Oliver, W.C. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). Contract F33615-84-C5067. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The compression deformation behavior of single crystalline TiAl was examined by transmission electron microscopy (T.E.M.). The relatively pure Ti-56 a/o Al crystal was containerless processed in ultrapure hydrogen. The crystal growth direction is 10° off (011) and 60° off (111) in the [011]-[111]-[010] unit triangle. At low stresses, a/2 [110] type dislocations were observed. a/2 [110] dislocations appeared at slightly higher stress. Additional plastic deformation initiates twinning. Twinning plays an important role at higher stresses. Diffraction results indicate that most of the twins have the (111) mirror plane. A small amount of (111) twins were also observed. Superdislocations of the a<011> type were not observed to contribute to the plastic deformation in this crystal.

30704 Tailored microstructures to control interfacial toughness. Oh, T.S. (Center For Advanced Materials, Lawrence Berkeley Lab., and Materials Science and Engineering Dept., Univ. of California, Berkeley, CA (US)); Cannon, R.M.; Ritichie, R.O. pp. 402 of Thin films: Stresses and mechanical properties. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8811222–: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

Failure of ceramic-metal interfaces in response to residual or applied stress is frequently effectively brittle owing to the propensity for interfacial cracking caused by weaker than average chemical bonds and elastic or plastic discontinuities at the interface. Stronger atomic bonding derived from improved interfacial chemistry can enhance fracture resistance to a degree which may be limited by diversion of the crack into the brittle ceramic. This paper reports on methods under study to promote interfacial fracture toughness in glass-Cu bonds via near-interfacial microstructures that encourage greater energy dissipation in a region near the interface fracture.

30705 Stress gradients and anisotropy in thin films. Fisher, R.M. (Center for Advanced Materials, Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (US)); Duan, J.Z.; Fox, A.G. pp. 402 of Thin films: Stresses and mechanical properties. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-8811222–: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

Indications that steep through-thickness strain gradients occur in vapor-deposited chromium films stemming from previous observations of film curling during spontaneous delamination from substrates, have been substantiated by analysis and simulation of Bragg x-ray diffraction peaks. The presence of large through-thickness compressive strains, that increase quadratically with distance from the substrate from about zero at the interface to around 0.8% at the film surface, was deduced by empirical computer matching of diffraction peak shapes.

30706 Ion-implantation of reactive elements in improving the adhesion of thermally grown Cr2O3 sales. Hou, P.Y. (Lawrence Berkeley Lab., CA (USA)); Stringer, J. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC03-76SF00098. (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

The high temperature oxidation behavior of AL, Y and Hf ion-implantation in Mi-25wt% Cr alloy with dosages ranging from 10^{15}-10^{17} ions/cm^2 has been studied. Results are compared with the unimplanted alloy, a Xe-implanted alloy and alloys with 0.2wt% Al additions. Oxidation testes were carried out at 1000°C and 1100°C in 1 atm. O_2. It is found that the ion-implantation dosage, 1×10^{16} ions/cm^2, has been reached. The improved scale adhesion is attributed to both a reduction in growth stress and a strengthened scale/alloy interface, which all developed as a result of a modified scale growth process.

30707 Molecular dynamics study of crack propagation in Ni-Al. Charpenay, S., Clapp, P.C. (Institute of Materials Science, Univ. of Conn., Storrs, CT (US)); Rifkin, J.A.; Yu, Z.Z.; Voter, A.F. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract FG02-87ER45310. Contract F33615-86-C-5037. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

Using an embedded atom method calculation of the interatomic potentials and volume forces in the Ni-Al alloy system, the authors examine the plastic and elastic response of an ordered bcc Ni-Al crystal with a pre-existing crack under Mode I loading at various temperatures, stresses and crystal orientation. Depending upon those conditions we found evidence of slip and dislocation generation near the crack tip concomitant with crack propagation. Evidence of a brittle to ductile transition above a certain temperature which is manifested by copious slip and dislocation production is reported. Atomic arrays up to 4000 atoms have been studied.

30708 Nanometer-scale shock-front structure in metals. Taylor, P.A. (Sandiaa National Lab, Albuquerque, NM (US)); Dodson, B.W. pp. 471 of Atomic scale calculations in materials sc.ance. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

Molecular dynamics shock wave simulations have been performed, which for the first time include a realistic many-body description of the atomic interactions. The authors discuss how the structural instabilities observed in the shock-front structure are dramatically influenced by the many-body effects of these atomic interactions.

30709 Proton irradiation-induced disordering reactions, ductility and strengthening of Ni_3Al. Cheng, J. (Dept. of Materials Science and Engineering, Univ. of California, Los Angeles, CA (US)); Lee, C.S.; Wagner, C.N.J.; Ardell, A.J. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Ordered Ni_3Al containing 24 at.% Al was irradiated by 2 MeV protons at – 45°C to a fluence of 1.34×10^{16} H$^+$/mm^2. The induced microstructural changes were investigated by transmission electron microscopy, x-ray diffraction, scanning electron fractography and microhardness measurements. Proton irradiation produced a large volume fraction of small disordered zones residing in the ordered matrix. The morphology of the disordered zones bears some striking similarities to tweed microstructures. X-ray diffraction reveals distinct splitting of the higher order fundamental peaks toward low angles, and broadening of the displaced peaks, indicating that the zones observed are small clusters of tetragonally distorted disordered Ni_3Al. The microhardness measurements suggest that the disordered zones strengthen the remaining ordered matrix considerably, most likely through a precipitation strengthening mechanism. The fractographic observations suggest that an increase in ductility accompanies disordering, as evidenced by the appearance of dimples, slip markings and river patterns on the fracture surface of the irradiated region of the sample.

30710 Compositional effects on processing and properties of nickel aluminides. Sikka, V.K. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (US)). pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Compositional effects on hot and cold workability of ductile- ordered nickel aluminides are described. Compositional effects studied include variations of chromium, aluminum, iron, and zirconium. The hot and cold workability of various nickel- aluminide alloys was ranked with respect to workability of stainless steel. The nickel-aluminide alloy containing chromium and low zirconium (IC-218LZr) had the best combination of hot and cold workability. This alloy also offered a good combination of strength and ductility values over a range of test temperatures.

30711 Grain-boundary design of $L1_2$ ordered intermetallic alloys. Liu, C.T. (Metals and Ceramics Div.). pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant,

C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC05-84OR21400. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

This paper summarizes recent research on intergranular fracture and alloy design of $L1_2$ ordered Ni_3X intermetallics. The grain boundaries in Ni_3Al, Ni_3Si, and Ni_3Ge are intrinsically brittle, and boron additions are effective in ductilizing the first three alloys but in Ni_3Ge. The beneficial role of boron is to increase grain-boundary cohesive strength, to enhance plastic flow in the boundary region, and to disorder grain boundaries. Boron is ineffective in ductilizing Ni_3X alloys with $X > 25\%$. The room-temperature ductility of undoped Ni_3Al can be improved also by change in grain shape from equiaxed to columnar.

30712 Unlubricated sliding wear of nickel aluminides at room temperature and 400 ° C. Bonda, N.R. (The Ohio State Univ. Dept. of Materials Science and Engineering, Columbus, OH (US)); Rigney, D.A. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Unlubricated sliding tests were performed at room temperature and at 400°C on polycrystalline Ni_3Al with and without boron and on IC218, an alloy containing nickel plus 8.94 Al, 7.55 Cr, 0.88 Zr, 0.015 B and 0.01 Hf (all in wt. %). A pin/disk geometry was used with self-mated samples in air and vacuum ($1.3x10^{-3}$Pa). Normal load was 1.5 kg (14.7 N), sliding speeds were 15-19 mm/s and sliding distance were 145-175 m. It had been expected that materials with and without boron would behave differently during sliding because of their well-known differences in ductility and fracture resistance. However, sliding behavior ws similar for materials with and without boron. Environmental effects were more dramatic. For tests in vacuum, the friction trace was very noisy and the average coefficient of friction varied erratically during most of each test. Wear debris ranged from 100 μm to 1 mm in size. Wear scars were smooth, but with signs of heavy deformation. All test materials exhibited smoother sliding behavior in air than in vacuum, but the wear rate was usually higher in air. Debris particles were finer, most of them were at least partially oxidized, and they included at least one ferromagnetic component, probably arising from selective oxidation. It is suggested that the increased wear rate in air is related to oxygen-enhanced fracture of these nickel aluminides.

30713 Recrystallization behavior of $Ni_3Al(B)$. Gottstein, G. (Dept. of Metallurgy, Mechanics and Materials Science, Michigan State Univ., East Lansing, MI (US)); Kim, W. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

The recrystallization kinetics, structure development, stored energy of cold work, and rolling and recrystallization textures were studied on boron doped $Ni_{76}Al_{24}$. The recrystallization kinetics were very slow compared to pure metals or disordered solid solutions, but similar to other intermetallic compounds. The development of the deformed and recrystallized microstructure is similar to metals with intermediate stacking fault energy. Despite a lack of massive deformation twining the rolling texture is a typical brass type texture. The recrystallization texture is not a brass type recrystallization texture, but consists of components, which are related by a 25° ⟨100⟩ rotation among each other and with the deformation texture. The observed phenomena are attributed to the constraints of grain boundary motion in long range ordered structures. It is further shown that Ni_3Al does undergo dynamic recrystallization during high temperature deformation.

30714 Fatigue/creep interactions in Ni_3A1-base alloys. Camus, G.M. (Materials Engineering Dept. Rensselaer Polytechnic Institute Troy, NY (US)); Duquette, D.J.; Stoloff, N.S. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). Contract N00014-84–0276. (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Stress-controlled fatigue tests and fatigue crack growth rate tests respectively have been carried out on two Ni_3Cr/Zr alloys, IC 218 at 600°C and 800°C, and IC 221 at 800°C, in vacuum, at various test frequencies. Decreasing the test frequency and/or increasing the temperature leads to a decrease in the number of cycles to failure, and a gradual disappearance of a fatigue fracture zone. In fatigue crack propagation tests, the crack growth rate only decreases at the lowest frequency and remains constant in the major part of the frequency range investigated. The fatigue propagation mode in all cases is intergranualar. These trends are shown in both cases to be related to a true creep component but, under fatigue crack growth test conditions, crack blunting intervenes gradually as the frequency is decreased, leading therefore to a less severe frequency effect.

30715 The effect of boron on microhardness in Ni_3A1 polycrystals. Qian, X.R. (Department of Materials Science and Engineering and Materials Research Center Lehigh Univ, Bethlehem, PA (US)); Chou, Y.T. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

In a recent symposium, the effect of boron on grain boundary hardness (GBH) in Ni_3Al was reported. Addition of 0.2 at.% of boron decrased the GBH in all three sets of alloys tested (24, 25, and 26 at.% Al). The present paper summarizes the study of the effect of boron on hardness within grains. Boron-induced softening was again obsrved in grain interiors. However, it occurred only in alloys with 24 and 25 at.% Al, but not in the alloy with 26 at.% Al. An explanation for this behavior is presented.

30716 Grain boundary cavity surface segregation in crept Ni_3Al + 0.2at% B and $Ni_3(Al,Hf)$ + 0.2at% B. Au-Yeung, P. (Dept. of Metallurgical Engineering, Michigan Technological Univ., Houghton, MI (US)); Lukowski, J.T.; White, C.L. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

Creep strengths and ductilities of boron-dopes nickel aluminides are significantly improved by small additions of hafnium. Since creep failure in these alloys proceeds by growth and coalescence of grain boundary cavities, effects of Hf additions on the compositions of grain boundaries and creep cavity surfaces were examined using Auger electron spectroscopy (AES). In order to facilitate intergranular fracture in the AES analysis chamber, gage sections from creep specimens were hydrogen charged and copper plated. Grain boundaries in crept specimens were not flat, and the grains did not exhibit a normal polyhedral appearance. The overall levels of boron detected on the fracture surfaces of the creep specimens were significantly higher than those from uncrept specimens. Additionally, boron was found to segregate more strongly to the grain boundaries while higher concentrations of residual sulfur and phosphorus were detected on the cavity surfaces in both alloys. These results are discussed in terms of the effects of impurity segregation on high temperature grain boundary cavitation.

30717 Biocorrosion studies of gold and rhodium ion implanted titanium and Ti-6Al-4V alloy. Lee, I.S. (Dept. of Materials Science and Engineering, The Univ. of Tennessee, Knoxville, TN, (US)); Buchanan, R.A.; Williams, J.M. pp. 806 of Biomedical materials and devices. Hanker, J.S.; Giammara, B.L. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-8711102–: Symposium on biomedical materials and devices, Boston, MA (USA), 30 Nov - 4 dec 1987).

Concern continues over the possible long-term biological effects of corrosion products released by degradation of metallic surgical implant materials in the human body. One approach to improve long-term biological performance involves surface modifications to significantly reduce degradation rates. Fundamentally, the elements with lowest driving forces for corrosion in aqueous solutions over a

wide pH range are the noble metals. With regard to surface-modifications, one of the most effective methods is through ion implantation. In the present on-going study, static in vitro corrosion properties of noble-metal ion-implanted surgical Ti-6Al-4V and commercially-pure (CP) Ti are investigated in nonpassivating acid and passivating saline solutions.

30718 **Influence of stoichiometry on the strength of nickel beryllide.** Nieh, T.G. (Lockheed Missiles and Space Co., Inc., Research and Development Div., Palo Alto, CA (US)); Wadsworth, J.; Liu, C.T. pp. 775 of High-temperature ordered intermetallic alloys III. Liu, C.T.; Taub, A.I.; Stoloff, N.S.; Koch, C.C. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811161–: 3. MRS symposium on high-temperature ordered intermetallic alloys, Boston, MA (USA), 28 Nov - 3 dec 1988).

It is demonstrated that the hardness of NiBe is dependant upon its stoichiometry; a minimum hardness is observed at the equiatomic composition. This behavior is similar to intermetallics that have the same crystallographic structure, e.g., NiAl and CoAl. The hardness increase for the off-stoichiometric compositions is a result of defect and anti-site defect structures, but may also, inpart, be caused by interstitial oxygen. Nickel beryllides appear to have some inrinsic room temperature ductility, as evidenced by the absence of cracking near hardness indications.

30719 **Phonons in Cu_3Au near the order-disorder transition.** Gaulin, B.D. (Solid State Division, Oak Ridge National Laboratory, Post Office Box 2008, Oak Ridge, Tennessee 37831-6031 (USA)—Department of Physics, McMaster University, Hamilton, Ontario, Canada L8S4M1 (Canada)); Hallman, E.D.; Svensson, E.C. *Physical Review Letters (USA),* 64(3): 289-292 (15 Jan 1990). DOE Contract AC05-84OR21400.

Selected phonon modes in Cu_3Au have been studied at temperatures in the vicinity of the order-disorder transition by neutron-scattering techniques. Marked changes occur predominantly at temperatures well below the region of the precipitous drop in the order parameter. Our results give considerable support to the concept of spinodal ordering near a discontinuous phase transition, and are consistent with a lower spinodal temperature of $T_c - 24$ K as inferred from earlier x-ray scattering results.

30720 **New high-pressure phase transition in zirconium metal.** Xia, H. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853 (USA)); Duclos, S.J.; Ruoff, A.L.; Vohra, Y.K. *Physical Review Letters (USA),* 64(2): 204-207 (8 Jan 1990). DOE Contract AC02-76CH00016.

Phase transitions in the group-IV transition-metal zirconium were studied by the energy-dispersive x-ray-diffraction technique with a synchrotron source to a pressure of 32 GPa. A first-order phase transition between an ω phase and a bcc phase (isostructural with group-V transition elements) was observed during compression and decompression in a pressure range of 30 ± 2 GPa, which is in qualitative agreement with the recent first principles theoretical predictions. The observation of the bcc phase in Zr (a group-IV element) under pressure at room temperature signifies a pressure-induced electronic configuration similar to that of a group-V element.

30721 **Influence of aging at 200 C on the corrosion resistance of Al-Li and Al-Li-Cu alloys.** Kumai, C. (California Univ., Berkeley, CA (USA). Dept. of Materials Science and Mineral Engineering); Kusinski, J.; Devine, T.M.; Thomas, G. *Corrosion (Houston) (USA),* 45(4): 294-302 (Apr 1989).

This paper presents an investigation of the influence of heat treatment on the microstructure and corrosion resistance of an aluminum lithium alloy and two aluminum-lithium-copper alloys. Aging the Al-Li alloy resulted in the precipitation of δ with precipitate-free zone (PFZ) formation along the grain boundaries. The intragranular precipitation of δ did not influence either the morphology of pitting or the magnitude of the pitting potential. Pits appeared to consist of aggregates of submicron-sized cuboidal volumes. Their faceted shape suggests the strong influence of crystallographic factors. Anodic polarization of the Al-Li-Cu alloy is the T8 condition in aqueous solutions containing chloride ions resulted in blistering of the passive film and the formation of pits that were hemispherical in shape. Aging the Al-Li-Cu resulted in the precipitation of Cu-rich phases with PFZ formation along the grain and subgrain boundaries. Energy dispersive x-ray (EDX) microchemical analyses indicated the PFZ was depleted of copper. Anodic polarization of aged samples in chloride ion media resulted in localized attack along the subgrain and grain boundaries. Such attack did not occur in solutions free of chloride ions. The electrochemical tests and microchemical analyses suggest that the boundary corrosion was caused by the pitting corrosion of copper-depleted zones.

30722 **Ultrasonic sensing of weld pool penetration.** Carlson, N.M. (Idaho National Lab., Idaho Falls, ID (US)); Johnson, J.A. *Welding Journal (Miami) (USA),* 67(11): 239-S-246-S (Nov 1988).

This paper reports how the geometry of the sidewall as it is penetrated by the weld pool during gas metal arc welding (GMAW) can be detected by high-frequency sound waves. The penetration geometry is detected using a piezoelectric transducer, operating in the pulse-echo mode, to generate shear sound waves that travel through the base metal to the weld region. The received echoes contain information that can be related to the sidewall penetration and thus to the quality of the weld. Different geometries can be discriminated using expert system methods, thus providing the potential of sending information on sidewall penetration to a closed-loop welding system for real-time feedback control to assure adequate sidewall penetration.

30723 **Optical second harmonic generation in metal monolayers and metal surfaces.** Furtak, T.E. (Physics Department, Colorado School of Mines, Golden, Colorado 80401 (US)); Miragliotta, J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 412-414 (20 Oct 1989). DOE Contract FG02-86ER45253. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Information about the structure of foreign metal monolayers can be obtained through measurements of the polarization dependence of optical second harmonic generation. We have used this phenomenon to monitor electrochemically controlled deposition of hexagonal metals on the (111) face of Ag. In the process, we have learned more about resonant second harmonic effects involving intrinsic excitations of the monolayer as well as surface influence within the Ag substrate.

30724 **Alkali metal adsorbates on W(110): Ionic, covalent, or metallic?.** Riffe, D.M. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (US)); Wertheim, G.K.; Citrin, P.H. *Physical Review Letters (USA),* 64(5): 571-574 (29 Jan 1990). DOE Contract AC02-76CH00016.

The photoemission signal from the first atomic layer of W(110) is used to assess the nature of the interaction between the surface atoms of the metal substrate and the adsorbates Na, K, and Cs for coverages up to 1 atomic layer. Our results indicate that there is little or no charge transfer from the alkali metal to the W surface, even in the limit of low coverage. The satellite structure of the photoemission lines of the outermost *p* shell of the alkali metals confirms this conclusion. While contrary to the conventional picture of alkali-metal-charge donation, these findings fully support recent theoretical calculations.

30725 **Magnetic properties and Fermi surface of antiferromagnetic $SmCu_6$.** Onuki, Y. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Umezawa, A.; Kwok, W.K.; Crabtree, G.W.; Nishihara, M.; Ina, K.; Yamazaki, T.; Omi, T.; Komatsubara, T.; Maezawa, K. *Physical Review, B: Condensed Matter (USA),* 41(1): 568-572 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

We report measurements of the magnetic susceptibility, specific heat, magnetoresistance, Hall effect, and Fermi surface in $SmCu_6$. The susceptibility follows the Van Vleck form for Sm^{3+} near room temperature and shows two antiferromagnetic phase transitions at 9.6 and 5.2 K. The specific heat implies a quartet ground state for the crystal-field-split $J=5/2$ angular momentum state. Magnetoresistance indicates that $SmCu_6$ contains both electron and hole carriers but is uncompensated. de Haas–van Alphen measurements show that the Fermi surface in the antiferromagnetic state consists of a network of cylinders oriented 30° from the *b* and *c* axes.

30726 Formation of metastable stuctures and amorphous phases in Pu-based systems using the sputtering technique. Rizzo, H.F. (Lawrence Livermore National Lab., CA (USA)); Echeverria, A.W.; Mossolski, T.B. *Metallurgical Transactions, A (Physical Metallurgy and Materials Science) (USA),* 20A(5): 813-824 (May 1989).

This paper reports the triode sputtering technique with a split-target arrangement used to obtain metastable crystalline and amorphous phases in ten binary systems of Pu with Si, Al, V, Fe, Co, Pd, Ta, Re, Os, and Ir. In addition to metastable extensions of solid solubility occurring from the binary sides of some systems, wide ranges of metallic glass formation have been observed in several systems. Extended bcc solid solution ranges were observed in Pu-Ta and Pu-V systems. Unlike the case of many liquid-quenched alloys, the ranges of amorphous phase formation obtained with sputtering appear to have little to do with the form of the corresponding phase diagram. However, the extent of the observed ranges on the Pu-rich side was found to obey approximately the atomic size mismatch relationship. The nearest neighbor distances (NNDs) evaluated with X-ray diffraction show many unusual deviations from an assumed Vegard's Law, which can be interpreted in relation to the changing electronic configuration of the Pu atom when present in different environments. Exposure of several amorphous alloys to severe oxidation environments did not result in observable corrosion.

30727 Heat transfer during Nd: Yag pulsed laser welding and its effect on solidification structure of austenitic stainless steels. Zacharia, T. (Oak Ridge National Lab., TN (USA). Metals and Ceramics Div.); David, S.A.; Vitek, J.M.; Debroy, T. *Metallurgical Transactions, A (Physical Metallurgy and Materials Science) (USA),* 20A(5): 957-968 (May 1989).

This paper reports theoretical and experimental investigations carried out to determine the effect of process parameters on weld metal microstructures of austenitic stainless steels during pulsed laser welding. Laser welds made on four austenitic stainless steels at different power levels and scanning speeds were considered. A transient heat transfer model that takes into account fluid flow in the weld pool was employed to simulate thermal cycles and cooling rates experienced by the material under various welding conditions. The weld metal thermal cycles and cooling rates are related to features of the solidification structure. For the conditions investigated, the observed fusion zone structure ranged from duplex austenite (γ) + ferrite (δ) to fully austenitic or fully ferritic. Unlike welding with a continuous wave laser, pulsed laser welding results in thermal cycling from multiple melting and solidification cycles in the fusion zone, causing significant post-solidification solid-state transformation to occur. There was microstructural evidence of significant recrystallization in the fusion zone structure that can be explained on the basis of the thermal cycles. The present investigation demonstrates the potential of the computational model to provide detailed information regarding the heat transfer conditions experienced during welding.

30728 Surface magnetism in an exactly soluble many-body periodic-cluster model of bcc iron. Chen, C. (Department of Physics, University of Oregon, Eugene, Oregon 97403 (US)— Department of Physics, University of California, Berkeley, California 94720— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 9472 *Physical Review, B: Condensed Matter (USA),* 41(3): 1320-1326 (15 Jan 1990).

An exact solution of a two-dimensionally periodic two-site cluster, a {001} two-layer thin film with body-centered-cubic (bcc) crystal structure, is presented for iron. The purpose is to study the surface magnetism of bcc iron in a full many-body approach. The model consists of five *d* orbitals per site per spin, with interatomic hopping terms, a one-electron occupation energy for each orbital, and an on-site Coulomb interaction of the fullest generality allowed by atomic symmetry. A realistic local-density-approximation single-particle electronic structure is used. Crystal-field effects in the iron-film structure are discussed. The many-body energy-level spectrum and thermodynamic averages of energy and spin of the system are calculated. The physical picture for the enhancement of magnetization at the true iron surface is discussed.

30729 Highly symmetric Mn sites in icosahedral Ti-Mn. Jeong, E. (Department of Physics, Washington University, St Louis, Missouri 63130 (US)); Holzer, J.C.; Carlsson, A.E.; Conradi, M.S.; Fedders, P.A.; Kelton, K.F. *Physical Review, B: Condensed Matter (USA),* 41(3): 1695-1698 (15 Jan 1990). DOE Contract FG02-84ER45130.

We find that the ^{55}Mn NMR linewidth and Knight shift of icosahedral $Ti_{63}Mn_{37}$ (i-TiMn) are identical to those of the crystalline phases obtained upon annealing. Comparison of the linewidth in i-TiMn and a bcc Ti-Mn solid solution shows that the Mn sites in both phases have a nearly cubic or higher symmetry. These measurements and our analysis provide strong evidence for a large density of structurally ordered, highly symmetric sites in an icosahedral alloy and demonstrate that a high degree of structural disorder is not an intrinsic property of the icosahedral phase.

30730 Metastable phase formation in the Zr-Al binary system induced by mechanical alloying. Fecht, H.J. (W. M. Keck Laboratory of Engineering Materials, California Institute of Technology, Pasadena, California 91125 (US)); Han, G.; Fu, Z.; Johnson, W.L. *Journal of Applied Physics (USA),* 67(4): 1744-1748 (15 Feb 1990). DOE Contract FG03-86ER45242.

We have studied the sequence of phase transformations induced in the Zr-Al binary system by mechanical alloying of mixed Zr and Al powders. The structure of these materials has been studied by transmission electron microscopy and by x-ray diffraction measurements. Three different metastable phases have been found experimentally with variation of the initial composition x_{Al}: (1) a nanocrystalline supersaturated solid solution of α-Zr for $x_{Al} \leq 0.15$, (2) an amorphous phase for $0.15 < x_{Al} \leq 0.4$, and (3) a metastable face-centered-cubic phase for $x_{Al}=0.5$ with a grain size of 4 nm. The crystallization reaction of the amorphous phase was monitored by differential scanning calorimetry, and the kinetics of the reaction have been examined as well. A possible explanation based on thermodynamic arguments is given for the defect-driven vitrification of the crystalline Zr phase.

30731 Absence of volume metastability in bcc copper. Lu, Z.W. (Solar Energy Research Institute, Golden, Colorado 80401 (US)); Wei, S.; Zunger, A. *Physical Review, B: Condensed Matter (USA),* 41(5): 2699-2703 (15 Feb 1990). DOE Contract AC02-77CH00178.

A previous pseudopotential total-energy calculation on bcc copper revealed a structural metastability in the form of a double-well total-energy curve with two local minima (at 6% compression and 7% dilation relative to the observed equilibrium volume of the fcc structure), separated by a barrier. This was explained in terms of a symmetry breaking in the nonspherical components of the valence-electron charge density upon volume change. Our present all-electron calculation shows no such metastability; analysis of the response of the valence-electron charge density to volume deformations indeed shows no cause for such a metastability.

30732 Magnetic surface states on Fe(001). Brookes, N.B. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973 (US)); Clarke, A.; Johnson, P.D.; Weinert, M. *Physical Review, B: Condensed Matter (USA),* 41(4): 2643-2645 (1 Feb 1990). DOE Contract AC02-76CH00016.

The direct observation of magnetic surface states on Fe(001) is reported. A spin-polarized angle-resolved photoemission study identifies a minority surface resonance at $\bar{\Gamma}$ (2.40-eV binding energy) and a minority surface state at $\bar{X}$ (2.25-eV binding energy) in the surface Brillouin zone. The majority counterpart of the minority surface resonance is not observed. Good agreement with 7- and 13-layer full-potential linearized-augmented-plane-wave calulations is found for the minority $\bar{\Gamma}$ to $\bar{X}$ surface band. In addition, the 13-layer slab calculation is found to more correctly model the decay of the surface resonance into the bulk in contrast to the 7-layer slab where size effects play a role.

30733 Surface phonons in Cu/Ni superlattices. Mattson, J. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Bhadra, R.; Ketterson, J.B.; Brodsky, M.; Grimsditch, M. *Journal of Applied Physics (USA),* 67(6): 2873-2877 (15 Mar 1990). DOE Contract W-31109-ENG-38.

The modulation wavelength dependence of the surface-wave velocity in Cu/Ni superlattices has been investigated using Brillouin scattering. It is the first compositionally modulated system to be studied by this technique and the first for which elastic properties have been determined by both "macroscopic" methods and Brillouin scattering. Contrary to the enhancements previously reported in the biaxial modulus and in the Young's modulus, the modulus associated with the surface-wave velocity shows no evidence of anomalous behavior.

30734 Electronic and chemical properties of In and Sb adsorbed on Ge(100) studied by synchrotron photoemission. Rich, D.H. (Department of Physics, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801 (US)— Materials Research Laboratory, University of Illinois at Urbana-Champaign, 104 South Goodwin Avenue, Urbana, Illinois 61801) *Physical Review, B: Condensed Matter (USA),* 41(5): 3004-3016 (15 Feb 1990). DOE Contract AC02-76ER01198.

The initial stages of interface formation for In and Sb, each separately adsorbed on the Ge(100)-(2×1) surface, have been investigated for various submonolayer coverages with use of synchrotron-photoemission and high-energy electron-diffraction techniques. By examining the evolution of the substrate and adsorbate core-level line shapes during the adsorbate growth it is possible to deduce chemical and structural information. The dimer-related surface-shifted component of the Ge 3*d* core level is found to gradually convert into a component possessing a binding energy indistinguishable from the bulk component for increasing Sb coverages. For submonolayer In depositions, this surface-shifted component results in a chemically shifted interface component which is distinguishable from the emission from bulk atoms and unreacted Ge dimers. The resulting chemical shifts are consistent with expectations based on electronegativity arguments. For both In and Sb, the adsorbate-to-substrate bonding coordination number is obtained for various submonolayer coverages. The homogeneity of the adsorbate bonding is evaluated by examining the width of the In and Sb 4*d* core-level line shapes. The Fermi-level position relative to the gap for various In and Sb coverages and the Schottky-barrier heights are obtained. Photoemission from the valence bands shows a modification in the dimer-derived surface states upon In and Sb adsorption; the surfaces show little density of states at the Fermi level for coverages below 1 monolayer. Structural models for the In/Ge(100)-(2×2) and Sb/Ge(100)-(2×1) surfaces which correlate with the data are discussed.

30735 Development of an embedded-atom potential for a bcc metal: Vanadium. Adams, J.B. (Theoretical Division, Sandia National Laboratories, P.O. Box 969, Livermore, California 94551-0969 (US)); Foiles, S.M. *Physical Review, B: Condensed Matter (USA),* 41(6): 3316-3328 (15 Feb 1990).

An empirical embedded-atom potential for a bcc metal (vanadium) has been developed by fitting the embedding function, electron density, and pair interaction to the lattice constant, cohesive energy, elastic constants, and vacancy-formation energy. This potential has been used to calculate vacancy and divacancy properties, interstitial properties, thermal expansion, bulk-phonon dispersion, surface relaxation, surface energy, and liquid volume; in all cases the calculations are in reasonable agreement with experiment.

30736 Liquid membrane coated ion-exchange column solids. Barkey, D.P. To Dept. of Energy, Washington, DC. USA Patent 4886598/A/. 12 Dec 1989. Filed date 7 Mar 1988. USA Patent Application 7-164,659. Int. Cl. B01D 13/00. vp.

This patent describes an ion exchange composition useful for Separation of metal cations in an aqueous solution. It comprises: a plurality of cation exchange resin beads capable of being confined in close proximity to each other; and, a liquid membrane removably formed on the beads. The liquid membrane being permeable to metal cations in an aqueous solution, the liquid membrane including a carrier compound having a specificity for the cation sufficient to complex the cations in the membrane.

3602 Ceramics, Cermets, and Refractories

Refer also to citation(s) 30303, 30306, 30307, 30511, 30645, 30647, 30652, 30677, 30678, 30679, 30852, 30884, 30995, 30997, 30998, 31004, 31006, 31010, 31011, 31012, 31013, 31014, 31319, 31728, 31899, 31900, 31901, 31908, 31910, 31913

30737 (AD-A-217508/1/XAB) **Sequential Ar-O(2) sputtering of Y(2)O(3), BaF(2), and CuO targets for preparation of Y-Ba-Cu-O superconducting films without wet-O(2) annealing.** Bhushan, M.; Strauss, A.J.; Finn, M.C. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 4 Dec 1989. 4p. (JA-6363). Available from NTIS, PC A01/MF A01.

Pub. in Applied Physics Letter, Vol. 55, No. 23, 2438-2440(4 Dec 1989).

Superconducting Y-Ba-Cu-O (YBCO) films have been prepared by ex situ O_2 annealing of multilayer films deposited on yttria-stabilized zirconia substrates by sequential rf diode sputtering of Y_2O_3, BaF2, and CuO targets, all of which are chemically stable. If sputtering is performed in an Ar ambient, the as-deposited films contain sufficient F to require its removal by annealing in wet O_2 at about 800 C or above before the superconducting YBCO phase can be formed by annealing in dry O_2. However, sputtering in an Ar-O_2 ambient greatly reduces the F content, making it possible to obtain the superconducting phase by annealing in dry O_2 only. If the ambient contains about 20% O_2, films with Tc (R = 0) > 85 K can be prepared without wet-O_2 annealing. The Ar-O_2 process therefore has the potential for in situ preparation of superconducting YBCO films.

30738 (CEA-CONF-9950) **Local probe ($^{170}Yb^{3+}$) measurements of magnetic fields in $YBa_2Cu_3O_x$.** Hodges, J.A.; Bonville, P.; Vincent, E. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique. 1989. 4p. (CONF-8908143--: 8. international conference on hyperfine interactions, Prague (Czechoslovakia), 14-19 Aug 1989). Order Number DE90784604. Available from NTIS (US Sales Only), PC A02/MF A01.

We introduce the technique of studying the field dependence of the electro-nuclear energy levels of a rare earth to measure the magnetic field present at the rare earth/yttrium site in $YBa_2Cu_3O_x$. Measurements were made by ^{170}Yb spectroscopy. The hyperfine spectrum of the ground state Kramers doublet for Yb^{3+} ions diluted into this matrix is sensitive to fields in the range 100 to 2000G. Flux penetration and trapping at the local site level have been measured in superconducting samples. A molecular field exists on the rare earth site in non superconducting samples suggesting that the ordered Cu2 magnetic moments are intrinsically non colinear.

30739 (CEA-CONF-9951) **Magnetic polarization of Yb^{3+} by Cu^{2+} in Yb_2BaCuO_5.** Hodges, J.A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR). Service de Physique du Solide et de Resonance Magnetique); Sanchez, J.P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique. 1989. 3p. (CONF-8908143--: 8. international conference on hyperfine interactions, Prague (Czechoslovakia), 14-19 Aug 1989). Order Number DE90784603. Available from NTIS (US Sales Only), PC A02/MF A01.

The magnetic properties of Yb^{3+} in Yb_2BaCuO_5 have been examined using ^{170}Yb Moessbauer spectroscopy. The quadrupole and magnetic hyperfine parameters of the Yb^{3+} ground doublet at each of the two sites have been obtained. The Yb^{3+} magnetic polarisation is due uniquely to couplings with the ordered Cu^{2+} moments.

30740 (CEA-CONF-9963) **Induced magnetic moment on Cu(1) in $YBaCuO_x$ compounds.** Gillon, B. (Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR)); Petitgrand, D.; Delapalme, A.; Schweiss, P.; Collin, G. Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). 1989. 2p. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE90784602. Available from NTIS (US Sales Only), PC A02/MF A01.

The first investigation of a YBaCuO compound by polarised neutron diffraction (p.n.d.) on a $YBa_2Cu_3O_{6.5}$ single crystal, has revealed the existence of a small magnetic moment on Cu(1). We report here on new p.n.d. results on a x = 6.4 single crystal. The magnetisation density demonstrates an induced magnetic moment on Cu(1), m = 0.02 μ_B slightly larger than for x = 6.5, in the same conditions of temperature and field (T = 1.7 K, H = 5 T). The temperature and field dependence of the induced moment are discussed in connection with a model of antiferromagnetically coupled spins on Cu(1).

30741 (CONF-890421–13) **Computer-controlled ion beam sputter deposition of multicomponent oxides.** Kingon, A.I. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering); Auciello, O.H.; Ameen, M.S.; Soble, C.N.; Graettinger, T.M.; Rou, Shang Hsien; Krauss, A.R. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. From 91. annual meeting of the American Ceramic Society; Indianapolis, IN (USA); 23-27 Apr 1989. Order Number DE90010544. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Multicomponent oxide thin films are of increasing technological importance for integrated optics and for devices containing ferroelectric memories and superconducting sensors and Josephson junctions. Methods for fabricating these thin films within particular process constraints are briefly reviewed. A new method of computer-controlled ion beam sputter deposition is described. The method is applied to electrooptic $KNbO_3$ and superconducting $YBa_2Cu_3A_{7-\delta}$ thin films.

30742 (CONF-890421–14) **Deposition of electrooptic thin films.** Kingon, A.I. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering); Rou, Shang-Hsien; Ameen, M.S.; Graettinger, T.M.; Gifford, K.; Auciello, O.; Krauss, A.R. Argonne National Lab., IL (USA). [1989]. 18p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Contract N00014-88-K-0526. From 91. annual meeting of the American Ceramic Society; Indianapolis, IN (USA); 23-27 Apr 1989. Order Number DE90010543. Available from NTIS, PC A03/MF A01 - OSTI.

$KNbO_3$ thin films have been deposited on Si and MgO (100) substrates by a new ion beam sputter deposition system. It has been shown that, by choice of substrate and conditions, a variety of microstructures can be controllably achieved, varying from polycrystalline to epitaxial single crystal. In the case of the latter, two defect types have been observed, viz antiphase domains and 211-type growth twins. A structure has been postulated for the domain boundaries of the former. The relationships between microstructures and ferroelectric properties can now be investigated. Preliminary dielectric property measurements were made of polycrystalline films deposited on TiN/MgO (100) substrates. In the case of epitaxial $KNbO_3$ films on MgO substrates, light has successfully been coupled into the films, and the films show low scattering losses. 17 refs., 8 figs.

30743 (CONF-891093–28) **Sputtered superconducting films of $Bi_2Sr_2CaCu_2O_x$ made by low-temperature, in-situ growth.** Kampwirth, R.T.; Gray, K.E.; Andersen, P.H.; McDonald, D.B.; Miller, D.J. Argonne National Lab., IL (USA). [1989]. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989. Order Number DE90010092. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Composite target rf magnetron sputtering has previously been successfully employed to make superconducting films of $YBa_2Cu_3O_{7-x}$ in-situ at substrate temperatures $T_s < 700°C$. We report the successful growth of superconducting films of $Bi_2Sr_2CaCu_2O_x$ on single crystal MgO substrates by a low-temperature process using dc magnetron sputtering from a Bi-enriched composite target. Using a substrate temperature $T_s \approx 645°C$, metallic films with a superconducting onset of 90–100K and an extrapolated T_{c0} = 56K have been obtained. X-ray diffraction shows the films to be c-axis oriented. Electron microscopy reveals that the films are not significantly smoother than films which were post-annealed at 865°C, and that some segregation into nonsuperconducting phases had occurred. The exact mechanism by which crystallization and superconductivity occurs at such low temperatures is not yet known, but it can be speculated that the surface atoms are less constrained and thus have a smaller energy barrier to overcome in forming a crystal structure. 9 refs., 4 figs., 1 tab.

30744 (CONF-891093–29) **Studies on ion scattering and sputtering processes in ion beam sputter-deposition of high $T_c$superconducting films: The optimization of deposition parameters.** Ameen, M.S. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering); Kingon, A.I.; Auciello, O.; Krauss, A.R.; Ray, M.A. Argonne National Lab., IL (USA); North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering. [1989]. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38;FG05-88ER45359. From 36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989. Order Number DE90010538. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Ion beam sputter-deposition is one of the techniques used for synthesizing high $T_c$superconducting films in laboratory experiments. However, the scaling-up of this method for technological applications, such as in microelectronics, will require a better understanding of basic phenomena occurring during the deposition process. First results are presented here from experimental and computer simulation studies on ion scattering and sputtering processes. It is demonstrated that scattering of neutralized ions from the targets can result in undesirable erosion of, and inert gas incorporation in, the growing films, depending on the ion/target atom mass ratio and ion beam angle of incidence/target/substrate geometry. The studies indicate that sputtering by Kr^+ or Xe^+ ions is preferable to the most commonly used Ar^+ ions, since the undesirable phenomena mentioned above are minimized for the first two ions. These results are used to determine optimum sputter deposition geometry and ion beam parameters for growing high $T_c$films. 8 refs., 7 figs.

30745 (CONF-891119–123) **Studies on ion scattering and sputtering processes relevant to ion beam sputter deposition of multicomponent thin films.** Auciello, O. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering); Ameen, M.S.; Kingon, A.I.; Krauss, A.R.; Ray, M.A. Argonne National Lab., IL (USA). [1989]. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38;FG05-88ER45359. Contract N-00014-88-K-0525;Contract N-00014-88-K-0526;Contract D From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010071. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Results from computer simulation and experiments on ion scattering and sputtering processes in ion beam sputter deposition of high Tc superconducting and ferroelectric thin films are presented. It is demonstrated that scattering of neutralized ions from the targets can result in undesirable erosion of, and inert gas incorporation in, the growing films, depending on the ion/target atom ass ratio and ion beam angle of incidence/target/substrate geometry. The studies indicate that sputtering Kr^+ or Xe^+ ions is preferable to the most commonly used Ar^+ ions, since the undesirable phenomena mentioned above are minimized for the first two ions. These results are used to determine optimum sputter deposition geometry and ion beam parameters for growing multicomponent oxide thin films by ion beam sputter-deposition. 10 refs., 5 figs.

30746 (CONF-891119–125) **Critical current density, flux creep, and microstructure in a Bi-Sr-Ca-Cu-O system.** Shi, Donglu; Boley, M.S.; Chen, J.G.; Xu, Ming; Fang, M.M.; Welp, U.; Vandervoort, K.; Hong, J.M. Argonne National Lab., IL (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010457. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We measured magnetization hysteresis and zero-field-cooled magnetic relaxation for liquid-quenched Bi–Sr–Ca–Cu–O samples at various temperatures. We found that there is a close correlation between the magnetic behavior and the microstructures of the samples. The magnetization hysteresis greatly increases in the samples with a large amount of crystal defects such as precipitates and stacking faults in the matrix of the material. We also found that the flux creep is enhanced as a result of these microstructural changes. 6 refs., 3 figs.

30747 (CONF-891119–127) **Rf surface resistance measurements on the Pb-Bi-Sr-Ca-Cu-O system.** Lanagan, M.T.; Bohn, C.T.; Delayen, J.R.; Einloth, M.C.; Vogt, R.N.; Balachandran, U. Argonne National Lab., IL (USA). Nov 1989. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010412. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Wires were fabricated from the high-$T_c$superconductor $Bi_{0.7}Pb_{0.3}SrCaCu_{1.8}O_\delta$ (Pb-BSCCO) by an extrusion process. The specimens were sintered at times up to 14 days, and density was found to decrease for longer sintering times. Rf surface resistance data revealed that the onset of superconductivity occurred at 105K and that the transition was very broad.

30748 (CONF-891119–128) **Use of neutron diffraction in determining strains in high-temperature superconducting composites.** Kupperman, D.S. (Argonne National Lab., IL (USA)); Singh, J.P.; Majumdar, S.; Hitterman, R.L.; Faber, J. Jr. Argonne National Lab., IL (USA). Nov 1989. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010404. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Argonne Intense Pulsed Neutron Source and General Purpose Powder Diffractometer have been used to study high $T_c$metal oxide composites composed of yttrium barium copper oxide and silver. Neutron diffraction techniques were applied to composites with 15, 20 and 30% silver content by volume. We have observed that after hot pressing, the 30% Ag specimens contained both orthorhombic high $T_c$and tetragonal, non-superconducting phases near the center of the specimens but only tetragonal near the surface. The relationship of shift in Bragg peaks to strains of the constituents is discussed. 12 refs., 3 figs.

30749 (CONF-891119–131) **The use of curium as a rare earth substitute in high T_c-related compounds.** Soderholm, L.; Williams, C.W.; Welp, U. Argonne National Lab., IL (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009724. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report the synthesis of Cm_2CuO_4. The lattice constants of this material, determined by x-ray diffraction, show it to be a new member of the isostructural series R_2CuO_4 (R=Pr, Nd, Sm, Eu, and Gd). Analysis of magnetic measurements is consistent with a free-ion effective moment for Cm^{3+}, with no contribution to the susceptibility from Cu-ions. 14 refs., 2 figs.

30750 (CONF-891206–11) **Valence-defect chemical equilibria in nonstoichiometric $YBa_2Cu_3O_{7-\delta}$.** Carlson, K.D.; Morss, L.R.; Thorn, R.J. Argonne National Lab., IL (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International chemical congress of Pacific Basin Societies (PACIFICHEM '89); Honolulu, HI (USA); 17-22 Dec 1989. Order Number DE90010152. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Through models which are essentially nearest-neighbor lattice statistics, one can describe quantitatively the variation of the partial pressure of oxygen with temperature and composition of $YBa_2Cu_3O_{7-\delta}$. One can predict the role of localized thermodynamic equilibrium in the transport of electrical charge. 21 refs., 1 fig., 1 tab.

30751 (CONF-900206–7) **Chemical and crystallographic phase behavior in the $Ba_{1-x}K_xBiO_3$ system.** Hinks, D.G.; Jorgensen, J.D.; Richards, D.R.; Pei, Shiyou; Zheng, Ying; Dabrowski, B. Argonne National Lab., IL (USA). [1990]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990. Order Number DE90010072. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Two types of phase behavior are important in the $Ba_{1-x}K_xBiO_3$ system. The structural phase behavior for the oxygen- stoichiometric material may help in understanding the normal-state electrical properties which, in turn, determine the superconducting properties. The high-temperature chemical phase diagram will give information on the stability of the doped material as a function of temperature and oxygen partial pressure. This will provide direction for the synthesis effort by establishing conditions necessary to prepare high-quality samples as a function of composition. In the first part of the paper we will discuss a recent investigation of the chemical behavior of the system at one fixed partial pressure of oxygen and present a chemical phase diagram consistent with the results of this work. In the second part of the paper we will describe the crystallographic and superconducting behavior of the system (at full oxygen stoichiometry) as a function of potassium concentration. This will provides information on the structural aspects of the metal-semiconductor phase transition and, hopefully, may provide some information on the superconductivity in the system. 12 refs., 10 figs., 1 tab.

30752 (CONF-900206–8) **Microstructure of sputtered superconducting films of $Bi_2Sr_2CaCu_2O_x$ made by low-temperature, in situ growth.** Miller, D.J.; Grace, J.M.; McDonald, D.B.; Gray, K.E.; Kampwirth, R.T.; Driehuys, B. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Contract STC-8809854. From 119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990. Order Number DE90010067. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Superconducting films of $Bi_2Sr_2CaCu_2O_x$ have been sputtered onto single crystal MgO substrates using an in situ process at a substrate temperature of ~645°C. These c-axis oriented films exhibit an extrapolated T_{c0} of 56 K. Electron microscopy reveals that the films are not smoother than films which were post-annealed at 865°C, and that segregation and second-phase precipitation had occurred. It is evident that surface diffusion during in situ processing can enhance segregation in $Bi_2Sr_2CaCu_2O_x$ films. 7 refs., 7 figs.

30753 (CONF-900218–2) **Thermal and phase analysis of $YBa_2Cu_3O_{7-x}$ powder compacts with organic acid additives.** Parish, M.V. (CPS Superconductor Corp., Milford, MA (USA)); Hodge, J.D.; Hubbard, C.R. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Contract N00014-88-C-0512. From 3. international conference on ceramic powder processing science; San Diego, CA (USA); 4-7 Feb 1990. Order Number DE90010142. Available from NTIS, PC A02/MF A01 - OSTI.

Simultaneous DTA/TGA and x-ray diffraction patterns were used to examine the burnout behavior of orthorhombic and tetragonal $YBa_2Cu_3O_{7-x}$ powders with small amounts of organic additives in three different atmospheres. It was found that small amounts of organic materials containing carboxylic acids can decrease the phase purity of $YBa_cCu_3O_{7-x}$ at temperatures as low as 200°C. Generally, the organic material burns off at lower temperatures for the tetragonal powder compacts than for the orthorhombic compacts. Stronger organic acids burn-off at somewhat higher temperatures than weaker ones. Organic additive removal is still possible in an inert atmosphere (argon), but will degrade the $YBa_2Cu_3O_{7-x}$ into more simple oxide components; tetragonal powder mixtures are more sensitive to this damage than are orthorhombic powder mixtures. 1 ref., 2 tabs.

30754 (CONF-900287–2) **Synthesis of superconducting phase-pure $YBa_2Cu_4O_8$.** Balachandran, U.; Bisnek, M.E.; Goretta, K.C.; Tomlins, G.W.; Veal, B.W.; Poeppel, R.B. Argonne National

Lab., IL (USA). Dec 1989. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy; National Science Foundation. DOE Contract W-31109-ENG-38. From TMS symposium on high temperature superconducting compounds; Anaheim, CA (USA); 20-21 Feb 1990. Order Number DE90010455. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Solid state reaction of appropriate amounts of Y_2O_3, $BaCO_3$, and CuO for 2 h at 800°C in flowing oxygen with a total pressure of 2.7×10^2 Pa (2 mm Hg), followed by cooling and annealing at 750°C for 10 h in oxygen at ambient pressure, has produced orthorhombic $YBa_2Cu_4O_8$ ("124") as the main phase with $YBa_2Cu_3O_x$("123") as a impurity phase. The phase purity improved considerably and nearly phase-pure 124 was obtained upon annealing the as-calcined powder in oxygen at 800°C for 24 h under ambient pressure. Magnetization measurements performed using a low-field SQUID magnetometer showed superconducting transition temperature of 80 K. 20 refs., 5 figs., 1 tab.

30755 (CONF-900466–13) **Epitaxy of TiO_2 thin film on sapphire by MOCVD.** Chang, H.L.M.; You, H.; Parker, J.C.; Lam, D.J. Argonne National Lab., IL (USA). Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010054. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Epitaxial TiO_2 films have been successfully grown on sapphire substrate at temperatures from 400 to 800°C by thermally decomposing titanium isopropoxide in the presence of O_2 in a cold wall low pressure MOCVD system. Rutile film was grown on sapphire $(11\bar{2}0)$ at 800°C with (101) being the growth plane and $\langle 1\bar{1}0 \rangle$ being parallel to sapphire ⟨0001⟩. Anatase film was grown on sapphire (0001) at 400°C with (112) being the growth plane and $\langle 1\bar{1}0 \rangle$ being parallel to sapphire $\langle \bar{1}\$100 \rangle$. The film structure as a function of substrate surface orientation and growth temperature is discussed in detail. 7 refs., 5 figs.

30756 (CONF-900466–14) **The influence of ion implantation on the near-surface mechanical properties of ceramics.** McHargue, C.J. (Oak Ridge National Lab., TN (USA)); O'Hern, M.E.; Joslin, D.L. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010139. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ion implantation of ceramics such as Al_2O_3 and SiC may produce a highly damaged but crystalline surface layer or an amorphous surface. The specific structure depends upon the implantation parameters. Studies using microindentation techniques show that a crystalline implanted surface has a higher hardness (by 10 to 50%) than the corresponding unimplanted crystal but the elastic modulus is essentially unchanged. The hardness and elastic modulus of amorphous implanted surfaces are less than those of the crystalline material. Estimates of the residual stress have been obtained from microindentation tests. 20 refs., 8 figs.

30757 (CONF-900466–16) **Rheological and related colloidal aspects of aqueous processing that affect the development of microstructure.** Bleier, A.; Westmoreland, C.G. Oak Ridge National Lab., TN (USA). 6 Apr 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010124. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Shear flow in α-Al_2O_3 suspensions having a volume fraction of solids (ϕ) in the range between 0.17 and 0.50 was investigated between pH 4 and 12. It is Newtonian if the magnitude of the zeta potential exceeds a critical value which depends on ϕ; its value is 39 mV if $\phi = 0.40$ and 74 mV if $\phi = 0.50$. If this potential is less than the critical value, shear flow is pseudoplastic; its yield value markedly changes (e.g., 0 to >100 Pa) in a slightly ϕ-dependent, narrow pH range (<0.5 units). If a second oxide, t-ZrO_2, is present, its pH-dependent colloidal behavior governs the overall rheology, though its concentration may be only 11 % that of α-Al_2O_3. Scanning electron microscopy of composite pieces indicates that a detrimental, rheologically detectable interaction between α-Al_2O_3 and t-ZrO_2 can be avoided and the distribution of t-ZrO_2 can be optimized during pressure casting by control of pH to ensure Newtonian flow or a very low yield value when the flow is pseudoplastic.

30758 (CONF-900466–28) **Indentation fracture of brittle materials.** Lucas, B.N. (Vanderbilt Univ., Nashville, TN (USA)); Wert, J.J.; Oliver, W.C. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010709. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The response of four transparent materials, soda-lime glass, fused silica, single crystal (0001) Al_2O_3 and Y_2O_3-ZrO_2, to contact by a sharp indenter has been studied. In-situ observation and continuous monitoring of the load and displacement throughout the test allowed the indentation fracture sequence of the transparent materials to be characterized and also permitted the effects of these fracture events on the corresponding load displacement curves to be noted. It was found that if the cracks produced during indentation grew discontinuously, they manifested themselves in discontinuities in displacement on the corresponding load-displacement curve. 6 refs., 5 figs., 1 tab.

30759 (CONF-900466–30) **Direct defect imaging in the high resolution SEM [scanning electron microscope].** Joy, D.C. (Oak Ridge National Lab., TN (USA)). Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010712. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The theory of imaging crystallographic defects in solid specimens through the use of electron channeling contrast is reviewed and the necessary conditions for observation are deduced. It is shown that current high performance field emission scanning electron microscopes can meet these requirements and produce dislocation images from suitable materials. 10 refs., 6 figs.

30760 (CONF-900527–1) **Cation and anion tracer diffusion in $YBa_2Cu_3O_{7-\delta}$.** Routbort, J.L.; Chen, N.; Goretta, K.C.; Rothman, S.J. Argonne National Lab., IL (USA). Mar 1990. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From ICMC '90 topical symposium on high temperature superconductors: materials aspects; Garmisch-Partenkirchen (Germany, F.R.); 9-11 May 1990. Order Number DE90009708. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sintering, grain growth, deformation and oxygenation are examples of diffusion controlled processes which are important in the fabrication of high-temperature superconductors. It is well known, for example, that $YBa_2Cu_3O_{7-\delta}$ (123) requires oxygenation after sintering to achieve a nearly stoichiometric compound with the maximum possible superconducting transition temperature, T_C. Ceramic processing usually involves competition between such processes as grain growth and sintering. In general, there exists an ideal microstructure to maximize performance. However, because of the competition between the various kinetically controlled processes, the ideal microstructure cannot be easily achieved; one can, nevertheless, hope to optimize the microstructure if one has a detailed knowledge of the kinetics which control these processes. A knowledge of the diffusion coefficients, used in conjunction with processing for optimal microstructures, can lead to significant improvements in electrical properties and mechanical reliability. For these reasons, a comprehensive investigation of anion and cation diffusion in 123 has been undertaken. All oxygen ion diffusion measurements were carried out on samples which had been well equilibrated in order to eliminate any channel potential gradient so that the diffusion measurements yielded tracer and not chemical diffusion coefficients. Chemical diffusion of oxygen controls the oxygenation of 123 after sintering and its importance cannot be ignored. However, while the chemical and the tracer diffusivity are related, the proportionality factor is not well known and the tracer

diffusivity, D, is likely to yield more meaningful fundamental information. In this paper, the results of oxygen tracer diffusion in both poly- and single crystalline 123 will be presented.

30761 (CONF-900623–4) **The defect structure of ion and neutron irradiated $YBa_2Cu_3O_{7-\delta}$ single crystals.** Frischherz, M.C. (Argonne National Lab., IL (USA)); Kirk, M.A.; Liu, J.Z.; Zhang, J.P.; Weber, H.W. Argonne National Lab., IL (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Contract STC-8809854. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90010100. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Using transmission electron microscopy techniques, we have begun a program to study cascade defects in the high-$T_c$superconductor $YBa_2Cu_3O_{7-\delta}$. In situ ion irradiations in the High Voltage Electron Microscope (HVEM)-Accelerator Facility at Argonne National Laboratory were performed to simulate low dose neutron irradiation at both room temperature and 40 K. Diffraction contrast experiments performed in two-beam dark field conditions in different operating reflections indicated defect cascades with hydrostatic pressure-like strain fields. Visible cascade defect yields ranged from 0.3 – 1.0, depending on incident ion mass. High resolution micrographs revealed that at least some of these cascades have recrystallized regions that have rotated with respect to the surrounding lattice. Samples which were neutron irradiated to doses sufficient to produce overlapped cascades show a 'cellular' structure of good crystalline material surrounded by highly defective or amorphous cell walls. It is suggested that the recrystallization observed in isolated cascade defects produced by low dose ion irradiation provides the mechanism for the formation of the cellular structure at high damage levels. Correlation of microstructure with magnetic measurements of critical current density increased by neutron irradiation and electrical resistivity measurements of the superconducting to insulating transition under ion irradiation are suggested. 15 refs., 4 figs.

30762 (CONF-9004184–1) **Magnetic and resistive measurements of the upper critical field in intwinned single crystals of $YBa_2Cu_3O_{7-\delta}$.** Crabtree, G.W. (Argonne National Lab., IL (USA)); Welp, U.; Kwok, W.K.; Vandervoort, K.G.; Liu, J.Z. Argonne National Lab., IL (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 25. Yamada conference on magnetic phase transitions; Osaka (Japan); 13-16 Apr 1990. Order Number DE90010083. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

DC magnetization measurements of H_{c2} are used to establish a 3D Ginzburg-Landau model of the superconductivity near T_c. Resistive measurements of the characteristic $\sin^2\theta$ angular dependence associated with flux motion models show that only a fraction of the dissipation in the superconducting state is due to Lorentz force effects. 9 refs., 5 figs.

30763 (LA–11815-MS) **Characterization of solid state bonding between Coors AD-999 alumina and niobium.** Stout, M.G.; Lovato, M.L.; Geltmacher, A.; Zocco, T.G.; Jervis, T.R. Los Alamos National Lab., NM (USA). May 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. Order Number DE90010653. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have investigated a candidate model system for the study of bi-material fracture. We examined the mechanical and microstructural properties of a polycrystalline alumina (Coors AD-999)/pure polycrystal niobium solid-state bond. Samples were bonded in vacuum at 160°C for 15 min, 30 min, 1 hour, under pressures of 10.5 and 15.5 MPa. We tested the bonds in tension, and found a maximum strength of 87.8 MPa. We attributed the differences in strength measured for different bonding conditions to artifacts of our tensile test procedure rather than to differences in bonding time or pressure. We studied the polycrystal Al_2O_3/Nb interface with nanohardness, scanning electron microscopy and transmission electron microscopy techniques, and concluded that we could not measure a finite-width reaction zone between the Al_2O_3 and niobium. The sharpness of the interface band was greater than the resolution of the techniques we used to measure its width. The plastic properties of the pure niobium were measured in addition to the interface characteristics. We found that the niobium was very strain-rate sensitive, with a rate sensitivity exponent of m ~0.035 and a work-hardening exponent of 1/n ~0.017. On the basis of this study we have concluded that this Al_2O_3/Nb system would be appropriate for experimental fracture work. 13 refs., 5 figs., 4 tabs.

30764 (LA-UR–90-1313) **Transverse- and zero-field μSR [muon-spin-rotation] investigation of magnetism and superconductivity in $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$.** Cooke, D.W. (Los Alamos National Lab., NM (USA)); Jahan, M.S.; Kwok, R.S.; Lichti, R.L.; Adams, T.R.; Boekema, C.; Dawson, W.K.; Kebede, A.; Schwegler, J.; Crow, J.E. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900489–1: 5. international conference on muon spin rotation, relaxation and resonance, Oxford (UK), 9-12 Apr 1990). Order Number DE90010597. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Zero-field muon-spin-rotation (μSR) measurements on $(Y_{1-x}Pr_x)Ba_2Cu_3O_7$ [x = 1.0, 0.8, 0.6, and 0.54] show evidence for antiferromagnetic ordering of the Cu moments within the Cu–O planes, with Neel temperatures 285,220, 35, 30, and 20 K respectively. For x = 1.0 the local muon magnetic field is ~16 mT, but decreases to ~12 mT at 17 K, due to additional magnetic ordering. The zero-field data, in conjunction with transport data, allow construction of a complete diagram for this system. Transverse-field (1 kOe) μSR data for x = 0.2 (T_c= 75 K) show that the muon depolarization is determined primarily by the Cu nuclear moments for $T>T_c$. Fitting the superconducting-state data to a BCS model yields an extrapolated zero-temperature magnetic penetration depth of 2170Å. 9 refs., 3 figs.

30765 (ORNL/FTR–3605) **[Advances in welding, materials processing and evaluation]: Foreign trip report, April 14–25, 1990.** Moorhead, A.J. Oak Ridge National Lab., TN (USA). 10 May 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010799. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the 5th International Symposium of the Japan Welding Society titled "Advanced Technology in Welding, Materials Processing and Evaluation," at Makuhari, Tokyo, Japan; and afterwards visited facilities of Toshiba Corporation in Kawasaki and Yokohama. Ten invited lectures at the Symposium included such topics as laser material processing, microjoining, welding advances with computers, robotization, and the physics of welding processes. The invited paper presented by the traveler was titled "State of the Technology for Joining Ceramics for High-Temperature Structural Applications." The traveler also chaired a session on joining of ceramics. The Proceedings of the Symposium, which were published in two volumes and distributed at the meeting, are available to colleagues at ORNL involved in this type of research. Following the Symposium the traveler had discussions with researchers at Toshiba Corporation on their work on high-temperature superconducting ceramics, and on aluminum nitride and silicon nitride materials.

30766 (PB–90-861246/XAB) **Titanium nitride (tin) coatings. January 1972-January 1990 (a Bibliography from the COMPENDEX data base). Report for January 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 80p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning deposition methods, structures, properties, and applications of titanium nitride (TiN) coatings. Advantages of TiN coatings include excellent adhesion to substrates, resistance to abrasive wear and elevated temperatures, reduced friction with most workplace materials, and high chemical inertness. Deposition methods include chemical vapor deposition, physical vapor deposition, ion plating, magnetron sputtering, and activated reactive evaporation. TiN coatings on machine tools, dies, molds, high-speed steels, automotive parts, heat mirrors, and solar cells are discussed. Citations concerning machine tool wear are examined in a separate bibliography. (Contains 165 citations fully indexed and including a title list.)

30767 (PB–90-861790/XAB) **Ceramic bearings. June 1970-February 1990 (a Bibliography from the NTIS data base).**

Report for June 1970-February 1990. National Technical Information Service, Springfield, VA (USA). Mar 1990. 112p. Available from NTISPC N01/MF N01.

Supersedes PB–89-866008.

This bibliography contains citations concerning the fabrication and testing of bearings and bearing surfaces fabricated from ceramic materials. Included are analyses of various ceramic materials used for these bearings, generally tested under severe environmental and tribological conditions. Strength, contact phenomena, and wear are explored to evaluate the performance of the various materials. Ceramic bearings are used in engines, turbines, inertial instrumentation, and space systems. (This updated bibliography contains 194 citations, 13 of which are new entries to the previous edition.)

30768 (SAND–89-2804C) **The cracking of sol-gel films during drying.** Garino, T.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900466–29: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010821. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The cracking behavior of acidic silica sol-gel films during drying and low temperature heat treatment was studied. Films that cracked during drying exhibited a variety of unusual crack morphologies including sinusoidal cracks and parallel crack pairs. The effects of the water content of the sol and temperature on the critical thickness above which cracking of the films occurred were determined. The critical thickness decreased with increasing water content because the surface tension of the liquid in the pores of the gel increases with water content and because sols with low water concentrations did not gel until the solvent had evaporated. To determine why the critical thickness decreased with temperature, thermal analysis and shrinkage measurements of both constrained and unconstrained films were performed. Thermogravimetric analysis indicated that rapid weight loss occurred in the temperature region where the rapid decrease in critical thickness occurred. A small amount of shrinkage of the films also occurred in this region. Finally, shrinkage measurements of unconstrained films indicated that shrinkage was very anisotropic with nearly all of the shrinkage occurring in the plane of the film and very little in the thickness direction. 12 refs., 4 figs.

30769 (SAND–89-3131C) **Rheology and microstructure of concentrated suspensions.** Mondy, L.A. (Sandia National Labs., Albuquerque, NM (USA)); Graham, A.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900466–9: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90009976. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We give an overview of some of the experiments currently underway to study the coupling of the microstructure and rheology of concentrated suspensions. Nuclear magnetic resonance imaging, real-time x-ray radiography, and refractive index matching allow the viewing of particles in concentrated suspensions. Both shear flow experiments and falling ball rheometry are reviewed. In the slow flow of these suspensions of large, hard, particles in a viscous Newtonian fluid, colloidal forces are negligible and hydrodynamic forces dominate. Large local concentration changes are shown to occur rapidly in suspensions of uniform spheres subjected to flow between concentric rotating cylinders. Suspensions of spheres with a bimodal size distribution not only show similar phenomena, but also exhibit particle separation according to size. In addition, the large particles in the bimodal suspension migrate into ordered, concentric, cylindrical sheets, parallel to the axis of the cylinders. These sheets of particles rotate relative to each other. The particle migration and structure formation induced by this inhomogeneous shear flow is believed to be responsible for torque reductions and other anomalous behavior witnessed during the rheological testing of concentrated suspensions reported in the literature. Thus, suspensions may not always be characterized by a viscosity that is a scalar material property. Suspensions of fibers also show markedly different rheological properties when the particles are aligned by flow. Falling ball rheometry is shown to be an effective tool to determine the bulk viscosity of a suspension while only slightly influencing the microstructure. This is illustrated by showing that falling ball rheometry can isolate the effect of orientation on the viscosity of a suspension of fibers. 22 refs., 4 figs.

30770 (SAND–90-0966C) **Joining engineering ceramics.** Loehman, R.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900774–2: International Institute of Welding conference, Montreal (Canada), 23-24 Jul 1990). Order Number DE90010819. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Joining ceramics to metals requires solutions to both scientific and practical engineering problems. Scientific issues include understanding the fundamental nature of adhesion at metal-ceramic interfaces, predicting interfacial reactions, and understanding the relation between chemical bonding and mechanical stresses at the interface on the atomic level. Engineering a specific ceramic-metal joint requires finding the optimum among what may be inherently incompatible properties. The following review briefly outlines some of the different methods for joining ceramics. Following that, some fundamental aspects of ceramic joining are presented. The paper concludes with examples of ceramic bonding in several engineering ceramic systems.

30771 (UCRL-JC–103614) **SIC film deposited by pulsed excimer laser ablation.** Tench, R.J.; Balooch, M.; Connor, A.L.; Bernardez, L.; Olson, B.; Allen, M.J.; Siekhaus, W.J.; Olander, D.R. Lawrence Livermore National Lab., CA (USA). 19 Apr 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–25: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010634. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thin films of B - SiC were grown on Si substrates by excimer laser pulse ablation of bulk SiC. The films were examined by Auger electron, x-ray, and photoelectron spectroscopies. The film was smooth as monitored by scanning electron microscopy. Scanning electron and scanning tunneling microscopy showed inclusions in the deposited SiC film and laser ionization mass analysis detected SiC dimers in the vapor plume emitted from the target. 13 refs., 4 figs.

30772 Field-modulated microwave absorption study of Pb-modified Bi-Ca-Sr-Cu-O. Yau, W.F. (California Univ., Berkeley, CA (USA)); Ramesh, R.; Portis, A.M.; Weber, E.R.; Thomas, G.; Green, S.M.; Luo, H.L. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

High-resolution transmission-electron-microscopy (HRTEM) has established that samples of nominal composition $Bi_2Sr_2Ca_2Cu_4O_y$ prepared by solid-state reaction are of mixed phase. These samples are mostly composed of the 115K polytypoid structure found at grain-boundaries and at planar defects within grains. This paper reports on the partial replacement of Bi by Pb which leads to a single phase of the 115K polytypoid as determined from HRTEM. Low-magnetic-field modulated microwave absorption in the absence of Pb yields absorption onset associated with transitions around 115K and around 80K. The addition of Pb eliminates the lower temperature transition. This observation is consistent with the HRTEM observations and supports the general view that microwave absorption arises primarily from grain boundaries and planar defects.

30773 Structural aspects of the phase separation in $La_2CuO_{4.032}$. Chaillout, C. (Laboratoire de Cristallographie, CNRS, associe a l'Universite J. Fourier, 166X, 38042 Grenoble cedex (FR)); Chenavas, J.; Marezio, M; Cheong, S.W.; Fisk, Z.; Lehmann, M.S.; Morosin, B.; Schirber, J.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science

Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The average structure of superconducting $La_2CuO_{4.032}$ has been determined by single-crystal neutron diffraction data. The excess oxygen is located between two adjacent LaO layers. Its presence distorts the apical-oxygen sublattice in such a way that a short O-O bond is formed (1.64 Å). By scanning several hkl reflections, the authors have confirmed that a phase separation occurs below room temperature. The peaks of one phase are in agreement with the space group Cmca and the unit cell proposed by Jorgensen et al. and Cox et al.. However, a monoclinic unit cell is needed to index the second phase reflections.

30774 Studies of NiO-metal interfaces. Merkle, K.L. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Shao, B. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Transmission electron microscopy techniques were applied to investigate the structure of interfaces between noble metals and NiO. Interfaces between NiO and Pt or Cu were formed by diffusion bonding. NiO and Cu form aligned lattices, while no unique topotactical relationship was found for the NiO-Pt interfaces. Internal reduction of (Ni,Cu) was also used to investigate NiO-Cu interfaces at polyhedral Cu precipitates in a NiO matrix. The morphology and compositions of precipitates was studied for several reduction treatments. The formation of largely (111) interfaces during solid state reduction suggests that these planes of densest packing are associated with the lowest interfacial free energy. The quite large lattice mismatch is accommodated by misfit dislocations as observed by HREM.

30775 Fluorine-induced microvoids in amorphous silicon. Langford, A.A. (Solar Energy Research Institute, Golden, CO (US)); Mahan, A.H.; Fleet, M.L.; Bender, J. pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

The effects of fluorine incorporation on the microstructural and electronic properties of a-Si:H:F with 1-7 at.% F have been systematically studied. Films were prepared by direct photo-CVD of disilane with xenon difluoride as the fluorine source. The fluorine content was measured by infrared spectroscopy, x-ray photoelectron spectroscopy (XPS) and electron microprobe. Infrared spectra show that as the fluorine content increases, silicon dihydride bonding increases. Density measurements confirm that this is associated with an increase in microvoid content. With the increase in F and SiH_2, the photoconductivity decreases over two orders of magnitude. A review of the literature shows that the appearance of SiH_2 is a universal result of >1% F incorporation and is not limited to the present study. This suggests that fluorination of amorphous silicon is not beneficial for photovoltaic application.

30776 Nuclear relaxation rates at copper and oxygen sites in $YBa_2Cu_3O_7$. Hammel, P.C. (Terradata, San Francisco, CA (USA)); Takigawa, M.; Heffner, R.H.; Fisk, Z.; Ott, K.C. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report NMR measurements of the nuclear relaxation rate at all copper and oxygen sites in magnetically aligned powder samples of $YBa_2Cu_3O_7$. There is no peak in the oxygen relaxation rate below T_c at any oxygen site supporting the possibility that d-wave pairs are formed in the superconducting state. Comparison of the oxygen and copper rates in the planes reveals a characteristic temperature greater than T_c.

30777 Anomalous temperature dependence of Cu NMR line width and magnetization in $YBa_2Cu_3O_{7-\delta}$. Takigawa, M. (Los Alamos National Lab., NM (USA)); Hammel, P.C.; Heffner, R.H.; Fisk, Z.; Thompson, J.D.; Maley, M. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report an anomalous temperature dependence of the magnetization and the NMR line width at the planar Cu(2) and oxygen sites in the mixed state of aligned $YBa_2Cu_3O_{7-\delta}$ powder at relatively high field (≥30 kOe), where hysteresis of the magnetization due to flux pinning is not important. Both the magnetization and the NMR line width at all sites show a steep increase at low temperature. They found a much larger line width at Cu(2) sites than at oxygen sites when the magnetic field is applied perpendicular to the x-axis, indicating a very microscopic local field modulation.

30778 Improved adhesion for SiO_2 particles on silica substrates using helium-ion irradiation. Musket, R.G. (Lawrence Livermore National Lab., CA (USA)); Thomas, I.M. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

The authors have examined the effects of irradiation with 200 keV helium ions on the adhesion and optical transmission properties of 220 nm thick antireflective, optical coatings that consisted of layers of spherical, 20 nm diameter silica particles. In the as-deposited state these sol-gel coatings have very low adhesion to the fused silica subtrates. Results for adhesion and optical transmission have been obtained for doses of 10^{13}-10^{17} He/cm^2. Significant improvement in adhesion wasfound for doses exceeding about 2 $\times 10^{14}$ He/cm^2. Optical transmission measurements for wavelengths of 200-1200 nm show increasing absorption with dose. The authors have evidence that the helium ions decompose various contaminants in the coating into two types of degradation products. One is volatile and the other remains in the coating as optically absorbing species. UV/oxidative-gas treatment effectively removes the absorbing species.

30779 A unified appraoch to the description of high T_c oxides: Major normal and superconducting parameters. . Wolf, S.A. (Naval Research Lab., Washington, DC (USA)); Kresin, V.Z. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Using the Fermi liquid approach, one can evaluate the major normal and superconducting parameters of the cuprate superconductors. The anisotropy of both the electronic and crystal structure and the small values of the both the Fermi energy and the Fermi velocity are the key features of these materials. A complete description of experimentally observed behavior can be constructed using this approach. Also, an unconventional method of determining the strength of the electron-phonon coupling based on an analysis of heat capacity and neutron spectroscopy data has been developed. The results of this analysis lead to the conclusion that the cuprates are described by strong coupling, e.g. for $La_{1.85}Sr_{0.15}CuO_4$ the coupling parameter λ is approximately 2. Nevertheless, the observed high T_c values require an additional non-phonon mechanism. In this paper the authors summariza many of the results they have obtained and published previously. They also present some new results.

30780 Oxygen vacancy ordering in $YBa_2Cu_3O_{7-y}$. Sterne, P.A. (Lawrence Livermore National Lab., CA (USA)); Wille, L.T. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E.

Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

First principles total energy calculations have been performed for $YBa_2Cu_3O_x$ with x varying from 6.0 to 7.5. The results of these calculations have been used to determine the effective pair interactions for the oxygen ordering in the basal plane. The phase diagram calculated with these first principles pair interactions is in very good agreement with experiment. Comparison of the total energies for the O_6, $O_{6.5}$ and O_7 structures shows that the double-cell phase is thermodynamically stable.

30781 Monte Carlo simulation of oxygen ordering in $YBa_2Cu_3O_z$. Burmester, C.P. (California Univ., Berkeley, CA (USA). Dept. of Materials Science and Mineral Engineering); Ceder, G.; deFontaine, D.; Mann, M.E.; Wille, L.T. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Oxygen ordering in the basal plane of $YBa_2Cu_3O_z$ has been studied by Monte Carlo simulations of a two-dimensional anisotropic Ising model. The orthorhombic to tetragonal transition is found to be second order at high temperature in agreement with previous CVM calculations. At low temperatures, a cell-doubled orthorhombic phase appears near stoichometry z=6.5, intermediate between the single sell orthorhombic and tetragonal phases. At very low temperatures, long-lived transient O-Cu-O chain ordering is observed to lead to triple and fivefold unit cells. Where not obscured by transient ordering, the transition lines bordering the orthorhombic cell-doubled phase are found to be second order. The observed equilibrium and non-equilibrium structures correlates well with atomic resolution micrographs and diffractions data from the $YBa_2Cu_3O_z$ system.

30782 Creep behavior of an AL2O3-SIC composite. Lipetzky, P. (Brown Univ, Engineering Div, Providence, RI (US)); Nutt, S.R.; Becher, P.F. pp. 383 of High temperature/high performance composites. Lemkey, F.D.; Strife, J.R.; Fishman, S.G.; Evans, A.G. Materials Research Society, Pittsburgh, PA (USA) (1988). N00014-86-K-0125. (CONF-8804181–: MRS: high temperature/high performance composites, Reno, NV (USA), 5-9 Apr 1988).

The addition of SiC whiskers to Al_2O_3 causes significant improvement in mechanical properties, including fracture toughness, thermal shock resistance, and creep resistance. The creep response of a whisker-reinforced alumina composite has been measured using four-point flexural loading at temperatures of 1200 and 1300 C Composites were fabricated by hot-pressing a blend of alumina powder with 33 volume percent SiC whiskers. The creep data shows a stress-dependent stress exponent equal to 1 at low stress levels and ranging from 4-6 at higher stresses. The applied stress at which the transition occurred was temperature dependent and ranged from 50-125 MPa. Mechanisms of creep deformation were determined from TEM observations of specimens prepared from interrupted creep tests. Voids were observed at grain boundary-interface junctions in tensile regions and whiskers within the composite were sometimes oxidized where voids had formed. TEM observations from specific stages of steady state creep reached under different applied loads are presented, and the relative contributions of different deformation mechanisms are discussed.

30783 Fibers of $YBa_2Cu_3O_7$ by pendant drop melt extraction. Schwartzkopf, L.A. (Ames Lab., IA (USA)); Ostenson, J.E.; Athreya, K.S.; Finnemore, D.K. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports fibers of $YBa_2 Cu_3 O_7$ produced by pendant drop melt extraction, a technique in which the end of a rod of $YBa_2 Cu_3 O_7$ is melted with a hydrogen-oxygen torch and lowered onto the edge of a spinning wheel. Fibers up to 10 cm in length have been produced; usually the lateral dimensions were in the range from 20 to 125 μ m. The fibers required a heat treatment to make them superconduction; the T_c of heat treated fibers ranged from 88 to 90 K.

30784 Interfacial chemistry-structure and fracture of ceramic composites. Schoenlein, L.H. (Pacific Northwest Lab, Richland, WA (US)); Jones, R.H. Henager, C.H.; Schilling, C.H.; Gac, F. pp. 383 of High temperature/high performance composites. Lemkey, F.D.; Strife, J.R.; Fishman, S.G.; Evans, A.G. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC06-76RL01830. (CONF-8804181–: MRS: high temperature/high performance composites, Reno, NV (USA), 5-9 Apr 1988).

This paper reports on the interfacial chemistry and phases of SiC-reinforced Si_3N_4 composites evaluated by transmission electron microscopy (TEM) with associated x-ray energy dispersive spectroscopy (EDS) microanalysis, and Auger electron spectroscopy (AES). Hot-pressed Si_3N_4 (HPSN) composites reinforced with Nicalon SiC fibers of Tateho SiC whiskers and reaction-bonded Si_3N_4 (RBSN) composites reinforced with uncoated or coated VLS SiC whiskers have been evaluated. In the Nicalon fiber-reinforced HPSN, an interfacial phase composed of a layer of amorphous carbon and an adjacent layer of graphitic carbon was observed and is believed to assist fiber pullout during fracture of the composite. However, the fracture strength and toughness of these composites were considerably less than those of unreinforced HPSN. HPSN composites reinforced with Tateho SiC whiskers contained an interfacial phase believed to be similar to the intergranular phase found in the HPSN matrix. In RBSN composites fabricated with an Fe_2O_3, sintering aid, the VLS SiC whiskers were severely faceted by a reactive iron silicide phase despite C, BN, or SiO_2 coatings on the whiskers. When no sintering aid was used, the uncoated whiskers were not degraded and appeared to be strongly bonded to the RBSN matrix. The composites reinforced with SiO_2-coated whiskers possessed the highest fracture strength and toughness, and the composites reinforced with the BN-coated whiskers possessed the lowest fracture strength and toughness.

30785 Specific heat of High-T_c $YBa_2(Cu_{3-x}M_x)O_7$ with M=Cr or Zn. Kim, S. (Materials and Chemical Sciences Div., LBL, Univ. of Californa, Berkeley, CA (US)); Fisher, R.A.; Phillips, N.E.; Gordon, J.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports the effects of substitution of Cr and Zn for Cu in YBCO studied calorimetrically and by magnetic measurements. There is a qualitative correlation between the suppression of the superconducting transition and an increase in the concentration of localized moments in both cases.

30786 Lattice and electronic specific heat of $YBa_2Cu_3O_7$. Gordon, J.E. (Materials and Chemical Sciences Division, Lawrence Berkeley Lab, Univ. of California, Berkeley, CA (US)); Fisher, R.A.; Kim, S.; Phillips, N.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC03-76SF00098. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report specific heat measurements on $YBa_2Cu_3O_7$ (YBCO) from 78 to 284 K. The higher temperature data are well-represented as the sum of a term proportional to T and a harmonic lattice contribution. These data show no evidence of an anomaly in the temperature region 200–230 K. The data near T_c are consistent with the specific heat of a BCS superconductor that has a contribution from 3-dimensional Gaussian fluctuations.

30787 Low-temperature elastic constants of polycrystalline La_2CuO_4 and $La_{1.85}Sr_{0.15}CuO_4$. Ledbetter, H. (National Institute for Standards and Technology, Boulder, CO 80303. (US)); Kim, S.A.; Voilet, C.E.; Thompson, J.D. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Using ultrasonic methods, the authors have measured the 295-4 K elastic constants of superconductive $La_{1.90:0085}Sr_{0.15}CuO_4$ and nonsuperconductive La_2CuO_4. These materials show two elastic-constant similarities: nearly the same ambient-temperature elastic constants and an elastic-stiffness minimum in the 20–40 K region. Their principal difference is that La_2CuO_4 softens 3% during cooling, while $La_{1.90:0085}Sr_{0.15}CuO_4$ softens 30%. This reversible wide-temperature-range softening resembles a magnetic phase transition.

30788 Structural phase transition in single crystal $La_{2-x}Sr_xCuO_{4-y}$ superconductor studied by ultrasound. Ting, W. (Div. of Physics, The Norwegian Institute of Technology, and Div. of Applied Physics - SINTEF, N-7034, (NO)); Laegreid, T.; Fossheim, K.; Axe, J.D.; Hidaka, Y. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report elastic measurements on a single crystal $La_{2-x}Sr_xCuO_{4-y}$ high-T_c superconductor. Ultrasonic measurements of longitudinal sound velocity and attenuation were performed at 13 MHz. The strong anomalies in the elastic properties are ascribed to a tetragonal to orthorhombic phase transition at $T_0 \simeq 255$ K.

30789 Specific heat of the high-T_c superconductor $(Bi_{1.66}Pb_{0.34})Ca_2Sr_2Cu_3O_{10}$. Fisher, R.A. (Lawrence Berkeley Lab, Univ. of California, Berkeley, CA (US)); Kim, S.; Wu, Y.; Phillips, N.E.; Ledbetter, H.M.; Togano, K. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports the specific heat (C) measured for H = O and 7T in the ranges 0.4 to 20 K and 65 to 125 K. The coefficient of the low-temperature linear term in C was 0 ± 0.5 mJ/K^2·mole. On initial cooling, an anomaly in C was observed at T_c, but there were dramatic temperature hysteresis effects.

30790 Structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system. Pei, S. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Jorgensen, J.D.; Hinks, D.G.; Dabrowski, B.; Richards, D.R.; Mitchell, A.W.; Zheng, Y.; Newsam, J.M.; Sinha, S.K.; Vaknin, D. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report on the structural phase diagram of the $Ba_{1-x}K_xBiO_3$ system for $0 \leq x \leq 0.5$ and temperatures from 10 K to above 400 K. At room temperature the undoped compound, $BaBiO_3$, is monoclinic. With increasing x, the monoclinic phase successively transforms to orthorhombic, and then to cubic phases. As the symmetry increases, first the breathing-mode distortion and then the rotation of BiO_6 octahedra are eliminated. The superconducting composition, $x \geq 0.37$, is cubic at all temperatures.

30791 Theoretical studies of structural properties of the high-T_c superconductor $Y_1Ba_2Cu_3O_{7-x}$. Valkealahti, S. (Materials Science Div., Brookhaven National Lab., Upton, NY (US)); Welch, D.O. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC02-76CH00016. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Structural properties of the high temperature oxide superconductor $Y_1Ba_2Cu_3O_{7-x}$ have been studied by static lattice simulation methods. Empirical (ionic) potentials, derived on the basis of experimental data, are used to describe the basic structural properties of the superconducting oxides. Several potential models, with different location of the extra charge for the O_7 compound, have been tested with respect to experimental lattice parameters. Fair parametrizations have been found in almost all cases, but they are usually valid only for a specific oxygen content. However, potential models, consistent both for O_6 and O_7, have been found. The authors present the best of our ionic models, where, in O_7, two-thirds of the holes are distributed in the sheet-site oxygens and one-third in oxygens between the sheet and chain planes.

30792 Defect structures preceding amorphization by ion irradiations in $YBa_2Cu_3O_{7-\delta}$. Kirk, M.A. (Materials Science Div., Argonne National Lab, Argonne, IL (US)); Frischherz, M.C.; Liu, J.K.; Funk, L.L.; Thompson, L.J.; Ryan, E.A.; Ockers, S.T.; Weber, H.W. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Contract STC-8809854. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports transmission electron microscopy used to investigate defect microstructures in single crystals of $YBa_2Cu_3O_{7-\delta}$ as a function of ion irradiation dose at 300 K. Two qualitatively different defect microstructures were observed to precede amorphization. The transition between microstructures occurs at a damage level where published resistance versus temperature measurements indicate a transition from superconducting to insulating behavior.

30793 High resolution synchrotron x-ray powder diffraction study of the structure of $Tl_2Ba_2CaCu_2O_8$. Eibschutz, M. (AT and T Bell Lab, Murray Hill, NJ (US)); Van Uitert, L.G.; Grodkiewicz, W.H.; Cox, D.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC02-76CH00016. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports on polycrystalline material of approximate composition $Tl_2Ba_2CaCu_2O_8$ synthesized by melting oxides together, pressing pellets and heating in sealed quartz tubes. High resolution synchrotron x-ray powder data obtained at beam-line X7A at the National Synchrotron Light Source revealed a tetragonal phase with a = 3.8545, c = 29,322Å, and a few weak impurity peaks. Rietveld refinement based on space group I4/mmm gave results in essential agreement with those obtained in previous x-ray single crystal and neutron powder determinations, including appreciable positional disorder of the thallium and oxygen atoms in the Tl – O planes. The refined site occupancies were found to be high for Ca and low for Tl, consistent with partial substitution of the type $(Tl_{1.65}Ca_{0.35})Ba_2(Ca_{0.85}Tl_{0.15})Cu_2O_8$. However, the possibility that there is some Cu on the Tl sites cannot be excluded.

30794 Preparation of in-situ superconducting YBCO thin films by single target magnetron sputtering. Caley, C.E. (Stanford Univ. CA (US)); Collman, J.P.; Little, W.A. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). Grant CHE831852;CHE8814949. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports in-situ superconducting YBCO thin films grown on (100 MgO substrates using rf planar magnetron sputtering from single, sintered, stoichiometric, targets. The films are c-axis oriented with T_c(onset) = 90 K and T_c(zero) = 40–75 K. Processing variables and target characteristics strongly affect the composition and quality of these films. Control of variables such as substrate temperature, target-substrate orientation, oxygen and Argon partial pressures, target composition, target density, and target age is essential to achieve growth of high-quality superconductings.

30795 Transport critical currents in epitaxial $Y_1Ba_2Cu_3O_{7-x}$ thin films. Christen, D.K. (Oak Ridge National Lab., Oak Ridge, TN (US)); Klabunde, C.E.; Kerchner, H.R.; Sekula, S.T.; Feenstra, R.; Budai, J.D.; Thompson, J.R. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The epitaxial orientation of coevaporated $Y_1Ba_2Cu_3O_{7-x}$ thin films was identified and the transport critical current density J_c characterized. The best c-axis oriented films deposited on (100) $SrTiO_3$ substrate surfaces had properties that approached estimated material limits, with $J_c > 1$ MA/cm^2 in zero magnetic field at 85 K and showed a large dependence on magnetic field orientation, such that $J_c(H \perp c)/J_c(H \parallel c) \simeq 100$ at H = 60 kOe and 77 K. Triaxial [110]- and [103]-oriented films deposited on (110) substrate surfaces had significantly lower $T_c$and J_c values, and exhibited temperature dependencies indicative of normal weak-link arrays.

30796 Diamagnetic shielding and flux creep in a Tl-Ba-Ca-Cu-O thin film. Venturini, E.L. (Sandia National Lab., Albuquerque, NM (US)); Kwak, J.F.; Ginley, D.S.; Baughman, R.J.; Morosin, B. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Static magnetization data for a superconducting thin film based on the Tl-Ba-Ca-Cu-O system are presented and discussed. The film, deposited by electron-beam evaporation into a single crystal $SrTiO_3$ substrate, consists of large grains of two superconducting structural phases with their crystallographic c axes normal to the substrate. It exhibits substantial transport critical current density, large diamagnetic shielding, and activated flux creep, consistent with strong intergranular links but weak flux pinning.

30797 Critical currents and magnetic relaxation in neutron irradiated Y123. McHenry, M.E. (Los Alamos National Lab., Los Alamos, NM (US)); Willis, J.O.; Maley, M.P.; Thompson, J.D.; Cost, J.R.; Peterson, D.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Critical current densities have been inferred from magnetic hysteresis and volume pinning energies from magnetic relaxation measurements for neutron irradiated and unirradiated polycrystalline Y123 samples. Increases in the critical current densities,by factors of 2–3 in zero field and larger in a field, for the irradiated sample are observed. Large increases in the magnetic relaxation rate are also observed at H = 1 T. From the relaxation data and the amount of irreversible magnetization, pinning energies of 0.01–0.06 eV and 0.01–0.03 eV are inferred for the irradiated and unirradiated samples, respectively.

30798 The temperature and angular dependence of the upper critical field of $YBa_2Cu_3O_{7-\delta}$ crystals. Welp, U (Materials Science Div, Argonne National Lab, Argonne, IL (US)); Kwok, WK; Crabtree, G.W; Vanderboort, K.G; Liu, J.Z. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Contract STC-8809854. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The upper critical field is determined from the onset of diamagnetism in dc magnetization measurements. The slopes of the upper critical field are -1.9 T/K and -10.5 T/K corresponding to coherence lengths of 16 Å and 3 Å parallel and perpendicular to the CuO-planes. The angular dependence can be described with a 3D anisotropic Ginzburg-Landau theory with a critical field anisotropy of five.

30799 Pressure dependence of T_c IN $Nd_{1.85}Ce_{0.15}CuO_4$. Schirber, J.E. (Sandia National Lab, Albuquerque, NM (US)); Venturini, E.L; Morosin, B; Ginley, D.S. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports the pressure dependence of the superconducting transition temperature T_c measured to –8 kbar in a He pressure medium. The authors find $dT_c/dP = 0.0(\pm 0.02)$ k/kbar.k/kbar.

30800 Magnetization of neutron irradiated $YBa_2Cu_3O_{7-\delta}$ single crystals. Sauerzopf, F.M. (Atominstitut der Osterreichischen Univ., A-1020 Wien (AT)); Wiesinger, H.P.; Weber, H.W.; Crabtree, G.W.; Liu, J.Z. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

YBCO single crystals with very sharp transitions at T_c were subjected to reactor neutron irradiation at ambient temperature. The magnetization curves, which were measured in a SQUID magnetometer in fields up to 8 T, show increasing irreversibility and decreasing anisotropy with neutron fluence. Bean-model evaluations of critical current densities are presented and discussed in terms of induced flux pinningpinning centers.

30801 Microstructure and superconductivity of shock processed high T_c superconductors. Iqbal, Z. (Allied Signal Inc., Corp. Technology, Morristown, NJ (US)); Reidinger, F.; Eckhardt, H.; Thadhani, N.; Johnson, K.A.; Roa, K.V.; Ramakrishna, B.L.; Sharma, R. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Explosive shock compaction of furnace synthesized 1 micron size powders of $YBa_2Cu_3O_7$ and $Bi_2Sr_2CA\text{-}Cu_2O_8$ have been carried out both in the planar and cylindrical geometries. In both

cases interesting microstructures and near theoretical packing densities are obtained. However bulk superconductivity is degraded but restored with some interesting changes on reannealing. The tetragonal and orthorhombic $T1_2Ba_2CuO_6$ phases were successfully shock-synthesized in the time domain of micro-seconds at 100kbar. The products obtained ranged in phase purity from 85 to nearly 100%. The shocksynthesized tetragonal phase is a bulk superconductor with T_c (zero) of 55K. High resolution electron microscopy shows double copper layer defects in the shock synthesized tetragonal $T1_2Ba_2CuO_6$. The importance of shock induced defects and microstructures in the magnetic flux pinning mechanisms are discussed.

30802 Superconducting properties and flux pinning in Bi-Sr-Ca-Cu-O system. Shi, D. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Boley, M.; Chen, J.; Welp, U.; Vandervoort, K. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports on extremely dense glasses in the Bi-Sr-Ca-Cu-O system made by splat quenching. Single superconducting transitions at 110 K have been observed in crystallized samples from both resistivity and magnetization shielding experiments. Magnetization J_c has been found to increase greatly at high field (H = 5T) as copper and calcium rich precipitates are introduced into the system.

30803 Rare earth substituted 124 and 127 superconductors. Morris, D.E. (Lawrence Berkeley Lab., Berkeley, CA (US)); Asmar, N.G.; Wei, J.Y.T.; Sid, R.L.; Nickel, J.H.; Scott, J.S.; Post, J.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports how rare earth substitution has given a series of superconducting compounds in which T_c can be correlated with lattice parameters. Eight rare earth compounds with 124 structure, and five with 247 structure, are easily synthesized in oxygen at pressures between 10 and 70 bar. The 247 compounds are stable only within a narrow range of oxygen pressures bounded by the stability regions of the 124 and 123 phases. The T_cs of the 124 and 247 phases vary inversely with ion size. Surprisingly, the 247 compounds have much lower T_cs (45-55 K) than the 124 or 123 parent compounds. The basal plane areas of 247 are larger and orthorhombic distortions smaller than the corresponding 123 and 124, suggesting weaker bonding in the CuO_2 layers.

30804 Tunneling spectroscopy in $Ba_{1-x}K_xBiO_3$. Zasadzinski, J.F. (Illinois Institute of Technology, Chicago, IL (US)); Tralshawala, N.; Timpf, J.; Hinks, D.G.; Dabrowski, B.; Mitchell, A.W.; Richards, D.R. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Tunneling measurements have been performed on bulk samples of $Ba_{1-x}K_xBiO_3$ for x = 0.375 to 0.5 using the natural, surface oxide as the tunnel barrier. High bias conductance and second derivative measurements show features in the energy range 10 to 65 meV which are characteristic of phonon effects as seen in conventional superconductors. The structures appear at energies which correspond to peaks in the phonon density of states as measured by inelastic neutron scattering and Raman spectroscopy. These results indicate that phonon-mediated pairing is responsible for superconductivity in this compound.

30805 The electronic properties of high Tc superconductors probed by positron annihilation. Sundar, C.S. (Univ. of Missouri, Kansas City, MO (US)); Bharath, A.; Jean, Y.C.; Hinks, D.G.; Dabrowski, B.; Zheng, Y.; Mitchell, A.W.; Howell, R.H.; Wachs, A.L.; Turchi, P.E.A. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Positron lifetime in Ba-K-Bi-O is observed to decrease linearly with temperature in the range of 300 K to 50 K with no change across and below T_c. Plausible reasons for the observed temperature dependence of positron lifetime are discussed.

30806 Systematics in positron annihilation lifetime analysis of high Tc superconducting transitions. Howell, R.H. (Lawrence Livermore National Lab., Livermore, CA (US)); Radousky, H.B.; Wachs, A.L.; Fluss, M.J.; Turchi, P.E.A.; Jean, Y.C.; Sunder, C.S.; Chu, C.W.; Peng, J.L.; Folkerts, T.J. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Values of the positron lifetime have previously been observed to change with temperature below T_c in high T_c superconducting oxides. The authors report new measurements on $Ba_{.6}K_{.4}Bio_3$ and $Nd_{1.85}Ce_{.15}CuO_4$.

30807 Electron-positron momentum distribution measurements of high-Tc superconductors and related systems. Wachs, A.L. (Lawrence Livermore National Lab., P.O. Box 808, Livermore, CA (US)); Turchi, P.E.A.; Howell, R.H.; Jean, Y.C.; Fluss, M.J.; West, R.N.; Kaiser, J.H.; Rayner, Si, Haghighi, H.; Merkle, K.L.; Revcolevshi, A. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors discuss measurements of the 2D-angular correlation of positron annihilation radiation (ACAR) in La_2CuO_4, $YBa_2Cu_3O_7$ (YBCO), and NiO. The measurements for NiO are the first such 2D-ACAR measurements; the YBCO results are of a higher statistical quality than previously reported. The data are compared with complementary theoretical calculations and with each other. The authors discuss the implication of this analysis for ACAR studies of similar and related systems.

30808 Magnetic pair breaking in $Y_{1-x}Pr_xBa_2Cu_3O_7$. Radousky, H.B. (Lawrence Livermore National Lab., Livermore, CA (US)); Hahn, P.A.; Peng, J.L.; Shelton, R.N. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports how the upper critical fields, H_{c2}, for $Y_{1-x}Pr_xBa_2Cu_3O_7$ are observed to be bell shaped for x (gte)0.3. This provides strong evidence for the importance of magnetic interactions in this system.

30809 Transport and tunneling in $Bi_2Sr_2CaCu_2O_{8-x}$. Crommie, M.F. (Dept. of Physics, Univ. of California, and Materials and Chemical Sciences Div., Lawrence Berkeley Lab, Berkeley, CA (US)); Briceno, G.; Zettl, A. pp. 1744 of Proceedings of the

international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC03-76SF00098. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report their measurement of the resistivity, TEP, Hall coefficient, and tunneling characteristics of single crystals of $Bi_2Sr_2CaCu_2O_{8-x}$ (BSCCO). Simple empirical expressions were found for the normal state transport coefficients that hold true for different crystal directions, oxygen contents, and for different classes of high T_c oxides. Tunneling measurements on BSCCO single crystals suggest an anisotropic or modulated gap below T_c with $2(cgd)_{ab}/k_BT_c$ (app) 6-7 and $2(cgd)_c/k_BT_c \approx 3$-4.

30810 Critical magnetic fields H_{c2},$H_{c1}$and $_k$ IN $YBa_2(Cu_{0.98}M_{0.02})_3O_{+\delta}$, M = Ni, Al, and Cu. Xu, Y. (Material Science Div., Brookhaven National Lab., Upton, NY (US)); Suenaga, M.; Moodenbaugh, A.R.; Peng, J.L., Shelton, R.N. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC02-76CH00016. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The upper critical magnetic field H_{c2} up to 5T and dM(T)/dH(single rule fence)$_{Hc2}$ for aligned powders of pure and Al and Ni substituted $YBa_2(Cu_{.98}M_{.02})_3O_{7+(gd)}$ are measured magnetically. dH_{c2}/dT(single rule fence)$_{Tc}$ is linear with slopes of −2.2T/K, −2.4T/K and −2.8T/K for the pure, Ni and Al samples respectively. This paper reports values of H_{c1}, $_k$, and (cgd)C/T_c deduced from dM(T)/dH(single fence rule)$_{Hc2}$.

30811 Theoretical calculations of x-ray-absorption spectra of copper in La_2CuO_4 and related oxide compounds. Guo, J. (Department of Physics and Astronomy—Northwestern University, Evanston, Illinois 60208 (USA)); Ellis, D.E.; Goodman, G.L.; Aip, E.E.; Soderholm, L.; Shenoy, G.K. *Physical Review, B: Condensed Matter (USA)*, 41(1): 82-95 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

We report the results of theoretical calculations of copper *K*-edge x-ray-absorption near-edge spectra (XANES) in La_2CuO_4 and related oxides Cu_2O, CuO, and $KCuO_2$. The final bound states were obtained from the self-consistent-field discrete-variational $X\alpha$ method (SCF DV $X\alpha$), and continuum states were found by the multiple-scattering method using the muffin-tin truncation of the SCF DV $X\alpha$ potentials. Composition of the final-state wave functions was analyzed. The 1*s* ionization potentials of the three reference compounds obtained from the SCF DV $X\alpha$ transition-state calculations were used to set up the relative energy scale for the calculated cross section. The principal features of measured Cu *K*-edge XANES for Cu_2O, CuO, and $KCuO_2$ were reproduced satisfactorily by our calculations along with their relative energy positions. Our calculated polarized XANES of La_2CuO_4 were compared with measured spectra, and two shakeup features were identified with radiation polarized along the crystal *c* axis. By quantitatively comparing the measured spectra with a model based on our calculated cross sections, their intensities were found to be ~24% and 10% of the main transition with shakeup energies of 5.7 and 9.5 eV, respectively. We suggest that these multielectron excitation features involve Cu 3*d*→4*p* transitions.

30812 Kondo effect and superconductivity in $Nd_{2-x}Ce_xCuO_{4-\delta}$ compounds. Peng, J.L. (Department of Physics, University of California-Davis, Davis, California 95616 (USA)); Shelton, R.N.; Radousky, H.B. *Physical Review, B: Condensed Matter (USA)*, 41(1): 187-192 (1 Jan 1990). DOE Contract W-7405-ENG-48.

Samples of $Nd_{2-x}Ce_xCuO_{4-\delta}$ ($0 \le x \le 0.2$) were prepared by annealing both in air and under vacuum (10^{-5} Torr). Powder x-ray-diffraction patterns indicated that all samples consisted of a single-phase Nd_2CuO_4-type tetragonal structure with crystal symmetry *I*4/*mmm*. Electrical resistivity measurements showed that all Ce-doped $Nd_2CuO_{4-\delta}$ samples annealed in air and those annealed in vacuum with $x<0.17$ demonstrate a resistivity minimum (Kondo effect) resulting from the combination of magnetic and phonon scattering. Magnetic susceptibility and electrical resistivity measurements reflect the influence of crystal-field effects below 55 K. The linear temperature-dependent term of the resistivity typical of metallic behavior in the high-T_c oxides exists across the whole range of Ce concentration, with the exception of the host compound $Nd_2CuO_{4-\delta}$, which is an insulator. This indicates that a model of metal-insulator transition is not appropriate in describing the occurrence of superconductivity in $Nd_{2-x}Ce_xCuO_{4-\delta}$.

30813 Light scattering from quantum spin fluctuations in R_2CuO_4 (R=La, Nd, Sm). Sulewski, P.E. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (USA)); Fleury, P.A.; Lyons, K.B.; Cheong, S.; Fisk, Z. *Physical Review, B: Condensed Matter (USA)*, 41(1): 225-230 (1 Jan 1990).

Raman spectra reveal spin fluctuation scattering over the energy range 0–8000 cm^{-1} (0–1 eV) in single crystal La_2CuO_4 (*T* phase), Nd_2CuO_4, and Sm_2CuO_4 (*T'* phase). From the B_{1g} symmetry spectra, values of the exchange parameter *J* for these crystals are determined to be 1030±50, 871±50, and 888±50 cm^{-1}, respectively. All three materials also exhibit broad spectral features of A_{1g} and B_{2g} symmetry, which are forbidden within the classical spin-pair excitation model, but allowed by quantum fluctuations. The line shapes for spectra of all three symmetries agree with recent model calculations for the planar quantum antiferromagnet. While the spectra for crystals with the *T'* structure are nearly identical, subtle differences from the spectra of La_2CuO_4 (*T* structure) indicate a sensitivity to the structure outside of the CuO_2 planes.

30814 Magnetoresistance and the spin-flop transition in single-crystal La_2CuO_{4+y}. Thio, T. (Center for Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (USA)); Chen, C.Y.; Freer, B.S.; Gabbe, D.R.; Jenssen, H.P.; Kastner, M.A.; Picone, P.J.; Preyer, N.W.; Birgeneau, R.J. *Physical Review, B: Condensed Matter (USA)*, 41(1): 231-239 (1 Jan 1990). DOE Contract AC02-76CH00016.

Measurements are reported of the magnetoresistance (MR) for fields up to 23 T in La_2CuO_4 single crystals, which order antiferromagnetically at $T_N \sim 240$ K, and in which the conductivity at low temperature is characterized by hopping in localized states. Using the MR, the phase diagram of the spin-flop transition, observed when the magnetic field is applied parallel to the zero-field staggered magnetization, is mapped out. Two transitions of the background Cu^{2+} spins are observed, which are governed by the symmetric and antisymmetric anisotropic components of the superexchange tensor. The antiferromagnetic propagation vector changes from $\tau \| a$ at zero field to $\tau \| c$ at the highest fields. This subtle change in the ordering of the Cu^{2+} spins is accompanied by a large enhancement of the interlayer hopping conductivity up to a factor 2. We show that the magnetoconductance is proportional to the three-dimensional staggered moment with $\tau \| c$ direction. In an appendix we discuss the possible relevance of these results to the behavior of superconducting $La_{2-x}(Sr,Ba)_xCuO_4$.

30815 Critical-current–free-energy relations in high-T_c superconductors. Athreya, K.S. (Ames Laboratory, U. S. Department of Energy and Iowa State University, Ames, Iowa 50011 (USA)); Sanders, S.C.; Hofreiter, D.; Finnemore, D.K.; Xu, Y.; Suenaga, M. *Physical Review, B: Condensed Matter (USA)*, 41(1): 264-266 (1 Jan 1990). DOE Contract W-7405-ENG-82;AC02-76CH00016.

Free-energy surfaces of a series of Fe-doped $YBa_2Cu_3O_{7-\delta}$ have been measured in order to look for a relation between the free energy per unit length of a vortex and the intragranular critical current density. Data for grain-aligned samples with the magnetic field parallel to the *c* axis show that Fe additions lead to large changes in the thermodynamic variables measured in the reversible region of the *H-T* plane and correspondingly large changes in the critical current density measured in the irreversible range. Both the free energy per unit length for the vortices and the critical current density fall exponentially with Fe concentration and are roughly proportional to one another.

30816 Infrared properties of single crystal MgO, a substrate for high temperature superconducting films. Yang, T. (Emory University, Physics Department, Atlanta, Georgia 30322 (US)); Perkowitz, S.; Carr, G.; Budhani, R.; Williams, G.; Hirschmugi, C.J. *Applied Optics (USA),* 29(3): 332-333 (20 Jan 1990). DOE Contract AC02-76CH00016.

We report and analyze the infrared properties of single crystal MgO, an important substrate for high T_c superconducting films, from 10 to 280 cm^{-1} and 20–300 K.

30817 Ground-state properties of a single oxygen hole in a CuO_2 plane. Frenkel, D.M. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853-2501 (USA)); Gooding, R.J.; Shraiman, B.I.; Siggia, E.D. *Physical Review, B: Condensed Matter (USA),* 41(1): 350-370 (1 Jan 1990). DOE Contract AC02-83ER13044.

The properties of a single O hole, either localized or mobile, in a CuO_2 plane are studied for an effective Hamiltonian derived from the extended Hubbard model in the strong-coupling limit. The ground-state wave function for a 16-Cu-site cluster is found exactly and compared with a semiclassical variational treatment of the same problem. In the ground state, whether localized or mobile, there is a long-range dipolar distortion of the Cu spin background around the O hole, as well as a strong antiferromagnetic correlation between the spin of the O hole and the two adjacent Cu spins (corresponding to the "3-spin polaron"). These correlations are forced by hopping and/or direct Cu-O exchange and can be saturated by either one of them, suggesting that the two processes have similar effects on the spin configuration and do not significantly interfere. The minimum of the mobile hole band lies at $k=(\pm\pi/2,\pm\pi/2)$ (at least in the presence of the small oxygen-oxygen hopping). The bandwidth scales with the Cu-Cu exchange and not the bare hopping, when the former is smaller. The ground state has spin $\frac{1}{2}$ with the z magnetization residing in the canting of the Cu spins, and the expectation value of the O spin vector being very nearly zero. Thus, both the quantum numbers of the mobile vacancy ground state, as well as the far-field structure of the Cu spin configuration, are the same as those found for the vacancy in the single-band t-J model.

30818 Phase separation in the t-J model. Emery, V.J. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973 (US)— Department of Physics, University of California-Los Angeles, Los Angeles, California 90024 (US)); Kivelson, S.A.; Lin, H.Q. *Physical Review Letters (USA),* 64(4): 475-478 (22 Jan 1990). DOE Contract AC02-76CH00016.

It is shown that, for the t-J model, dilute holes in an antiferromagnet are unstable against phase separation into a hole-rich and a no-hole phase. When the spin-exchange interaction J exceeds a critical value J_c, the hole-rich phase has no electrons. It is proposed that for J slightly less than J_c the hole-rich phase is a low-density superfluid of electron pairs. A brief discussion of phase separation in other related models is given.

30819 Effects of beam parameters on excimer laser deposition of $YBa_2Cu_3O_{7-\delta}$. Muenchausen, R.E. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Hubbard, K.M.; Foltyn, S.; Estler, R.C.; Nogar, N.S.; Jenkins, C. *Applied Physics Letters (USA),* 56(6): 578-580 (5 Feb 1990).

Broad angular distributions have been observed for XeCl laser ablation plumes used in the deposition of $YBa_2Cu_3O_{7-\delta}$ thin films. Distributions (inferred from film thickness) and film stoichiometry were measured as a function of laser fluence, beam shape, and oxygen pressure. Parallel to the long axis of the laser spot, plumes exhibited a $\cos^{3.5}(\theta)$ spread and composition varied with angle; in the perpendicular direction, more diffuse $[\cos^{1.5}(\theta)]$ plume distributions were associated with stoichiometric deposition. The observed phenomena are consistent with formation of a Knudsen layer near the target surface.

30820 Crystallization of amorphous Bi cuprate fibers to superconducting $Bi_2Sr_2Ca_1Cu_2O_8$. Miller, T.A. (Ames Laboratory, U. S. Department of Energy, Ames, IA (US)—Department of Physics, Iowa State University, Ames, Iowa 50011-3020 (US)); Sanders, S.C.; Ostenson, J.E.; Finnemore, D.K.; LeBeau, S.E.; Righi, J. *Applied Physics Letters (USA),* 56(6): 584-586 (5 Feb 1990). DOE Contract W-7405-ENG-82.

The conversion of long slender filaments of Bi-based high-temperature superconductors from the amorphous to the crystalline phase has been studied in order to determine the suitability of these fibers for use in a multifilamentary magnet conductor. For very fine filaments, coarsening may be a problem, so special emphasis was placed on the optimum values of time and temperature used for recrystallization. Amorphous fibers approximately 1 μm in diameter can be crystallized to form granular filaments about 0.2 μm thick (in the c direction) and 3 to 4 μm wide. The c axis generally grows perpendicular to the long axis of the fiber.

30821 Anomalous resistivity peaks, localization transitions, and the electronic structure of substoichiometric lanthanum trihydrides. Shinar, J. (Ames Laboratory-U.S. Department of Energy, Ames, IA (US)—Physics Department, Iowa State University, Ames, Iowa 50011-3020 (US)); Dehner, B.; Barnes, R.G.; Beaudry, B.J. *Physical Review Letters (USA),* 64(5): 563-566 (29 Jan 1990). DOE Contract W-7405-ENG-82.

The resistivity $\rho(T)$ of LaH_x ($2.80\leq x\leq 2.90$) was determined from Q-factor measurements at 100 K$<T<$700 K. Its temperature coefficient $\alpha>0$ is small at $T\leq 200$ K, and $\rho(T)$ peaks at some T between 220 and 260 K. The peak narrows with increasing x and is extremely sharp for $x\geq 2.86$. At higher temperatures the behavior of $\rho(T)$ is consistent with variable-range hopping. It is suggested that a delocalized band of states at E_F, associated with the superlattice of octahedral vacancies, becomes localized and its mobility is quenched when the superlattice collapses above ~240±20 K.

30822 Resonant photoemission study of $Nd_{2-x}Ce_xCuO_{4-y}$: Nature of electronic states near the Fermi level. Allen, J.W.; Olson, C.G.; Maple, M.B.; Kang, J.; Liu, L.Z.; Park, J.; Anderson, R.O.; Ellis, W.P.; Markert, J.T.; Dalichaouch, Y. *Physical Review Letters (USA),* 64(5): 595-598 (29 Jan 1990). DOE Contract FG03-86ER45230;W-7405-ENG-82.

The electronic structures of single-crystal and ceramic samples of the electron-doped superconductor $Nd_{2-x}Ce_xCuO_{4-y}$ with x=0 and 0.15 have been studied using resonant photoemission spectroscopy. Comparing these spectra with previous results for $La_{2-x}Sr_xCuO_4$ shows that for both electron and hole doping the Fermi level lies at nearly the same energy, in states that fill in the x=0 insulator gap. We point out that this would occur if the states at the Fermi level obey a Luttinger-type sum rule, i.e., according to standard theory, if the metallic state is a normal Fermi liquid.

30823 Measurement of T_{eff} for Cu in $YBa_2Cu_3O_7$ by neutron resonance absorption. Mook, H.A. (Solid State Division, Oak Ridge National Laboratory, Post Office Box 2008, Oak Ridge, Tennessee 37831-6393 (USa)); Harvey, J.A.; Hill, N.W. *Physical Review, B: Condensed Matter (USA),* 41(1): 764-765 (1 Jan 1990). DOE Contract AC05-84OR21400.

High-resolution transmission measurements were made at room temperature of the shape of the neutron resonance at 230.3 eV for ^{65}Cu for the high-temperature superconductor $YBa_2Cu_3O_7$. From the shape of the resonance the effective temperature T_{eff} for Cu in the compound was determined. An identical measurement was also made for Cu metal. T_{eff} for Cu metal was found to be 314±28 K, while the measurement for $YBa_2Cu_3O_7$ yielded a T_{eff} of 297±28 K. This shows that the Cu phonons in $YBa_2Cu_3O_7$ have the same energy scale as the phonons in Cu metal.

30824 Giant torque magnetization anisotropy in $Tl_2Ba_2CaCu_2O_x$ thin films. Gray, K.E. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (USA)); Kampwirth, R.T.; Farrell, D.E. *Physical Review, B: Condensed Matter (USA),* 41(1): 819-821 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

We report the first equilibrium torque measurements on a high-T_c superconducting film. The sample is a film of $Tl_2Ba_2CaCu_2O_x$ which exhibits a high degree of c-axis orientation, and the results indicate a giant superconducting effective-mass anisotropy of almost 10^4, and a recent determination from resistive transitions of the upper critical field on a similar film is consistent with this value. We also point out that such torque measurements form a basis for determining $H_{c2}(\theta)$.

30825 Direct observation of dissipative flux motion and pinning by twin boundaries in $YBa_2Cu_3O_{7-\delta}$ single crystals. Kwok, W.K. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Welp, U.; Crabtree, G.W.; Vandervoort, K.G.; Hulscher, R.; Liu, J.Z. *Physical Review Letters (USA)*, 64(8): 966-969 (19 Feb 1990). DOE Contract W-31109-ENG-38.

We present the first direct observation of Lorentz-force-induced dissipative flux motion and the effect of twin boundaries as pinning centers in a single crystal of $YBa_2Cu_3O_{7-\delta}$ with twin planes oriented in a single direction.

30826 Theoretical studies of small copper oxide clusters and possible relevance to superconductivity. Wulfman, C.E. (University of the Pacific, Stockton, CA (USA). Dept. of Physics); Curtiss, L.A. *International Journal of Modern Physics B (USA)*, 3(8): 1287-1298 (Aug 1989).

Ab initio molecular orbital computations indicate that in a $(CuOH_2)^{3+}$ complex oxygen hole (pX type orbital)) formation is favored over Cu^{3+} formation. In contrast, it is found that in a $(Fe(H_2O))^{3+}$ complex oxygen hole formation is much less favorable, thus, suggesting a reason for the depression of T_c upon Cu substitution by Fe in $YBa_2Cu_3O_{7-x}$. Computations on a symmetrical $(Cu(H_2O)_4)^{3+}$ cluster indicate that it has a degenerate unrestricted Hartree-Fock (UHF) ground state in which the oxygen hole is strongly coupled adiabatically to nuclear motions. The electronic repulsion energy of the ground state is, as a result, lowered by a combination of vibrational and electronic correlation effects. The relevance of these observations to the existence of high temperature superconductivity in cuprates is discussed.

30827 Mechanical properties of polycrystalline lithium orthosilicate. Chu, C.Y. (Argonne National Lab., IL (USA). Materials and Components Technology Div.); Bar, K.; Singh, J.P.; Goretta, K.C.; Billone, M.C.; Poeppel, R.B.; Routbort, J.L. *Journal of the American Ceramic Society (USA)*, 72(9): 1643-1648 (Sep 1989).

Room-temperature mechanical properties and high-temperature creep deformation of lithium orthosilicate (Li_4SiO_4) were studied. Elastic constants, flexural strength, and fracture toughness were determined for specimens with densities between 68% and 98% of theoretical. Critical quenching temperature and thermal-shock resistance parameters for 90% dense specimens were also measured. High-temperature creep deformation was investigated by a constant-strain-rate test in an argon atmosphere at temperatures between 750° and 1025°C and strain rates ranging from about 10^{-6} to 10^{-3} s^{-1}. AT 950°C and above, the stress exponent, n, was determined to be 3.6, with a creep activation energy of 715 kJ/mol. Selected results obtained for Li_4SiO_4 are compared with the results obtained for other Li-containing ceramics that are under consideration as candidates for fusion reactor breeder blankets.

30828 Theoretical investigation of intra-atomic electronic excitation energies of divalent Cu in $YBa_2Cu_3O_{7-x}$. Curtiss, L.A. (Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439-4837 (US)); Tam, S.W. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1824-1828 (1 Feb 1990). DOE Contract W-31109-ENG-38.

Ab initio molecular-orbital calculations of small CuO clusters are used to investigate intra-atomic electronic excitation energies of divalent Cu in $YBa_2Cu_3O_{7-x}$. In clusters representing the CuO_2 planes, all of the Cu d-d excitation energies are found to be in the range 1.3–1.8 eV. The presence of an O $2p_\pi$ hole has only a small effect on the excitation energies. Similar results are found for clusters having geometries representing the chains. The relation of the results to experimental optical spectra of $YBa_2Cu_3O_{7-x}$ is discussed.

30829 Structural properties of oxygen-deficient $YBa_2Cu_3O_{7-\delta}$. Jorgensen, J.D. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Veal, B.W.; Paulikas, A.P.; Nowicki, L.J.; Crabtree, G.W.; Claus, H.; Kwok, W.K. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1863-1877 (1 Feb 1990). DOE Contract W-31109-ENG-38.

The structural properties of oxygen-deficient $YBa_2Cu_3O_{7-\delta}$ have been determined by neutron powder diffraction for $0.07<\delta<0.91$. The samples were produced by quenching into liquid nitrogen from controlled oxygen partial pressures at 520 °C, and they exhibit a clearly defined "plateau" behavior of T_c versus δ. Superconductivity disappears at the orthorhombic-to-tetragonal transition that occurs near δ=0.65. Structural parameters, including the copper-oxygen bond lengths, vary smoothly with δ within each phase but exhibit different behavior in the superconducting and nonsuperconducting phases. These observations are consistent with a model in which superconducting behavior is controlled by charge transfer between the conducting two-dimensional CuO_2 planes and the CuO_x chains, which act as reservoirs of charge.

30830 Structure of T^*-phase superconductors: Anomalous x-ray-diffraction study of cation ordering in $LA_{0.9}Gd_{0.9}Sr_{0.2}CuO_4$. Kwei, G.H. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Von Dreele, R.B.; Cheong, S.; Fisk, Z.; Thompson, J.D. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1889-1893 (1 Feb 1990).

Although it has been postulated on the basis of relative ionic sizes that the heavy cations in the newly discovered T^*-phase cuprate superconductors are ordered between the two available sites in the space group $P4/nmm$, there has been no direct experimental evidence that such ordering actually takes place. We have carried out a detailed x-ray-diffraction study of T^*-phase $La_{0.9}Gd_{0.9}Sr_{0.2}CO_4$ at four x-ray wavelengths, including one each near the absorption edge of each heavy cation in order to obtain the contrast variation necessary to gain information about cation ordering. We find the smaller Gd^{3+} are located in the smaller T'-phase (Nd_2CuO_4) positions (M' site) and (with less certainty) that Sr^{2+} are located in the larger T-phase (La_2CuO_4) positions (M site). The La^{3+} is located mostly in the M site, with the remainder in the M' site, to fill the occupancies in both sites. In addition, diffraction data taken at low temperature show the crystal symmetry to be the same at both room temperature and 19 K.

30831 Superconducting and normal-state magnetic-susceptibility anisotropy in $YBa_2Cu_3O_7$. Lee, W.C. (Ames Laboratory-U.S. Department of Energy, Ames, IA (US)—Department of Physics, Iowa State University, Ames, Iowa 50011 (US)); Johnston, D.C. *Physical Review, B: Condensed Matter (USA)*, 41(4): 1904-1909 (1 Feb 1990). DOE Contract W-7405-ENG-82.

Measurements of the superconducting and normal-state magnetic-susceptibility χ anisotropies of high-purity grain-aligned powder samples of $YBa_2Cu_3O_7$ are reported. Excellent alignment was achieved using a noncontaminating *in situ* technique. We find a strong temperature-dependent anisotropy $\Delta\chi=\chi_c-\chi_{ab}$ that decreases from positive values for $T>T_c$ to negative values for $T<T_c$, consistent with reported torque-magnetometer measurements on single crystals. Estimates of the normal-state spin contributions to χ are obtained and compared with previous results.

30832 On the improvement of $DyBa_2Cu_3O_{7-\delta}$ properties through better sintering. Seuntjens, J.M. (Applied Superconductivity Center and Department of Materials Science and Engineering, University of Wisconsin, 1500 Johnson Drive, Madison, Wisconsin 53706 (US)); Larbalestier, D.C. *Journal of Applied Physics (USA)*, 67(4): 2007-2016 (15 Feb 1990).

The sintering of $DyBa_2Cu_3O_{7-\delta}$ has been improved by controlling powder size, sintering temperature, and sintering atmosphere. Sintering below the eutectic temperature has been explored for different temperatures and oxygen partial pressures. Sintering kinetics have been enhanced, yielding high density (up to 95%) and small grain size (down to 1.5 μm) with shorter sintering times and lower temperatures. Two sets of samples, one set containing 10-wt. % Ag_2O in the precursor powder and one undoped set, were studied. The sintering rate decreased with decreasing temperature, even in samples sintered in low partial pressures of oxygen (which increase the oxygen vacancy concentration). The addition of Ag_2O yielded a dispersion of Ag particles about one-half the $DyBa_2Cu_3O_{7-\delta}$ grain size at grain boundary triple points. Ag tended to enhance grain growth slightly and did not improve the superconducting properties. Resistivity was as low as 220 $\mu\Omega$-cm at 100 K. Transport critical current densities (J_{ct}) were up to five times higher than in previous larger grain size samples that were sintered above the eutectic temperature. The best of the new samples achieved ~100 A/cm^2 at 4.2 K in fields of 1–7 T. This improvement occurred in spite of there being more than twice as

much grain boundary surface area per unit volume. We conclude that the grain boundaries in sintered 123 compounds are not always barriers to current flow, and that increasing the proportion of nonbasal plane faced grain boundaries is important in raising J_{ct}.

30833 Longitudinal electroptic effects and photosensitivities of lead zirconate titanate thin films. Land, C.E. (Sandia National Labs., Albuquerque NM (US)). *Journal of the American Ceramic Society (USA)*, 72(11): 2059-2064 (Nov 1989). DOE Contract AC04-76DP00789.

The feasibility of storing and reading high-density optical information in lead zirconate titanate (PZT) and in lead lanthanum zirconate titanate (PLZT) thin films depends on both the longitudinal electrooptic coefficients and the photosensitivities of the films. This paper describes the methods used to measure the longitudinal electrooptic effects and the photosensitivities of the films. The results of these measurements were used to evaluate a longitudinal quadratic electrooptic R coefficient, a longitudinal linear electrooptic r_c coefficient, and the wavelength dependence of the photosensitivity of a composition of PZT polycrystalline thin film. The longitudinal electrooptic R and r_c coefficients are about an order of magnitude less than the transverse R and r_c coefficients of bulk ceramics of similar compositions. This is attributed to clamping of the film by the rigid substrate. The large birefringence of the films after poling ($>10^{-2}$) suggests that the optic axes of the films are preferentially oriented normal to the film surface. The techniques used in this paper for evaluating the photosensitivities of thin films are based on measuring the photocurrent generated rather than the reduction in coercive voltage (as in bulk ceramics) when the film is exposed to light.

30834 Variable normal-state transport properties of $Bi_2Sr_2CaCu_2O_{8-y}$. Crommie, M.F. (Department of Physics, University of California at Berkeley, Berkeley, CA (US)—Materials and Chemical Sciences Division of the Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Liu, A.Y.; Cohen, M.L.; Zettl, A. *Physical Review, B: Condensed Matter (USA)*, 41(4): 2526-2529 (1 Feb 1990). DOE Contract AC03-76SF00098.

The normal-state thermoelectric power S and resistivity ρ of crystalline $Bi_2Sr_2CaCu_2O_{8-y}$ are strongly influenced by oxygen configuration. In general, the temperature dependences of the coefficients follow simple empirical expressions. For the *ab*-plane and *c*-axis thermopower, $S \sim A + BT$, while for the *ab*-plane resistivity, $\rho \sim T^{\alpha} \exp[\Delta/k_B T]$. Only A and Δ depend on oxygen configuration. These expressions may hold also for other classes of high-T_c superconducting oxides and are suggestive of and place restrictions on normal-state transport models; normal-state transport models should in turn relate to superconductivity mechanisms.

30835 Improved high-field performance of $Pb_{1-x}Sn_xMo_6S_8$ ribbons. Capone, D.W. II (Supercon Inc., Shrewsbury, Massachusetts 01545 (US)); Hinks, D.G.; Brewe, D.L. *Journal of Applied Physics (USA)*, 67(6): 3043-3046 (15 Mar 1990). DOE Contract W-31109-ENG-38.

This paper describes the effect of Sn additions to $PbMo_6S_8$ ribbons. These ribbons are produced via a vapor-transport technique. Small amounts of Sn in $Sn_{1-x}Pb_xMo_6S_8$ alloy ribbons provide a significant ($\sim 10\times$) increase in J_c at high fields over that obtained with $PbMo_6S_8$ alone. Critical current densities of 1×10^4 A/cm^2 at 4.2 K near 20 T have been achieved for compositions with x near 0.5. The low J_c's in $PbMo_6S_8$ appears to be related to the presence of a large fraction of a nonsuperconducting triclinic phase resulting from a partial phase transition at cryogenic temperatures. This phase transition is partially suppressed with Sn additions, resulting in an improved performance.

30836 Near-infrared reflectance modulation with electrochromic crystalline WO_3 films deposited on ambient temperature glass substrates by an oxygen ion-assisted technique. Arntz, F.O. (Electro-Optics Technology Center, Tufts University, Medford, Massachusetts 02155 (US)); Goldner, R.B.; Morel, B.; Hass, T.E.; Wong, K.K. *Journal of Applied Physics (USA)*, 67(6): 3177-3179 (15 Mar 1990). DOE Contract FG03-85SF15927.

Electrochromic, crystalline WO_3 films have been deposited on glass substrates at ambient temperature by an oxygen-ion-assisted technique using oxygen ion energies $\geq$300 eV and oxygen ion to vapor molecule (WO_3) ratios, $\gamma \geq 2.5$. After lithiation, the resulting Li_xWO_3 films exhibited >50% reflectivity in the near infrared, and the reflectivity dispersion was fit by a Drude free-electron model, yielding the Drude parameters: plasma energy, E_p=3.3 eV; and the loss (damping) parameter, E_T=1.0 eV. (The bound electron permittivity, ϵ_b, was fixed at 4.0.) These values are comparable to those obtained with WO_3 films rf sputter deposited onto substrates at temperatures >420 °C. During the ion-assisted deposition the substrate temperature reached approximately 90 °C, caused primarily by radiation from the WO_3 evaporant source. This indicates that economical low-temperature substrates, such as plastics, could be used. These results suggest that practical electrochromic smart windows for energy-efficient buildings might be produced using ion-assisted deposition techniques.

30837 Process for making transition metal nitride whiskers. Bamberger, C.E. To Dept. of Energy, Washington, DC. USA Patent 4883559/A/. 28 Nov 1989. Filed date 12 Apr 1988. USA Patent Application 7-180, 753. Int. Cl. CO1B 21/06. 6p.

This patent describes a process for making metal nitrides, particularly titanium nitride whiskers, using a cyanide salt as a reducing agent for a metal compound in the presence of an alkali metal oxide. Sodium cyanide, various titanates and titanium oxide mixed with sodium oxide react to provide titanium nitride whiskers that can be used as reinforcement to ceramic composites.

30838 Method for heat treating and sintering metal oxides with microwave radiation. Holcombe, C.E.; Dykes, N.L.; Meek, T.T. To Dept. of Energy, Washington, DC. USA Patent 4880578/A/. 14 Nov 1989. Filed date 8 Aug 1988. USA Patent Application 7-229,892. Int. Cl. C04B 35/64. 8p.

A method for microwave sintering materials, primarily metal oxides, is described. Metal oxides do not normally absorb microwave radiation at temperatures ranging from about room temperature to several hundred ° centrigrade are sintered with microwave radiation without the use of the heretofore required sintering aids. This sintering is achieved by enclosing a compact of the oxide material in a housing or capsule formed of a oxide which has microwave coupling properties at room temperature up to at least the microwave coupling temperature of the oxide material forming the compact. The heating of the housing effects the initial heating of the oxide material forming the compact by heat transference and then functions as a thermal insulator for the encased oxide material after the oxide material reaches a sufficient temperature to adequately absorb or couple with microwave radiation for heating thereof to sintering temperature.

3606 Other Materials

Refer also to citation(s) 29953, 29987, 30040, 30083, 30141, 30244, 30251, 30308, 30429, 30515, 30652, 30678, 30679, 30684, 30690, 30698, 30704, 30903, 30969, 31000, 31005, 31009, 31012, 31031, 31295, 31296, 31303, 31304, 31306, 31307, 31308, 31309, 31321, 31325, 31422, 31657, 31715

30839 (AD-A-217189/0/XAB) **Compendium of abstracts and viewgraphs. International workshop on composite materials and structures for rotorcraft (2nd). Held Rensselaer Polytechnic Institute, Troy, New York on September 14-15, 1989. Report for 1 December 1988-30 November 1989.** Diefendorf, R.J. Rensselaer Polytechnic Inst., Troy, NY (USA). 30 Nov 1989. 549p. Available from NTIS, PC A23/MF A03.

A workshop was conducted, dealing with the fundamentals of composite constituent materials and laminates as they influence applications to advanced rotorcraft developments. Included in the purview of the workshop were the theory, numerical analysis, fabrication, testing, and inspection of thermoset & thermoplastic resin matrix and metal matrix composites as they may have advantage for rotors, fixed airframe, drive system, controls, and engine cold section components. Rotorcraft composite materials & structures; Rotary wing aircraft.

30840 (CONF-891119–124) **Surface enrichment and evaporation in a polymer mixture of long and short chains.**

Composto, R.J. (Massachusetts Univ., Amherst, MA (USA). Polymer Research Inst.); Stein, R.S.; Felcher, G.P.; Mansour, A.; Karim, A. Argonne National Lab., IL (USA). Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010073. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Neutron reflectivity has been used to determine the concentration profile at the vacuum-polymer interface for a two polymer blend. To quantify surface enrichment and evaporation due to differences in chain length, we have measured the reflectivity of a mixture of short deuterated and long protonated polystyrene chains (DPS & PS), with a weight fraction of 0.5. When a mixture of DPS and PS chains of molecular weight 720 and 910k respectively were annealed, a small but measurable increase in asymptotic reflectivity occurred, coupled with a decrease of film thickness and scattering length density. This is indicative of surface enrichment and evaporation of the light chains (DPS). Ellipsometry studies confirmed that the short chains evaporated and its rate was established as a function of the temperature. Upon increasing the DPS molecular weight to 9600, the enrichment becomes considerably greater whilst the evaporation becomes negligible. 3 figs.

30841 (CONF-900513–1) **Fracture toughness and solid-particle erosion of ceramic-matrix whisker-reinforced composites.** Routbort, J.L.; Goretta, K.C.; Chu, C.-Y.; Singh, J.P. Argonne National Lab., IL (USA). Feb 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Conference on the tribology of composite materials; Oak Ridge, TN (USA); 1-3 May 1990. Order Number DE90009713. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fracture toughness and solid-particle erosion resistance of several ceramic whisker-reinforced ceramic matrix composites have been measured. Systems include Al_2O_3 + SiC(w), Si_3N_4 + Si_3N_4(w), Si_3N_4 + SiC(w) and Y_2O_3-stabilized ZrO_2 + Al_2O_3(w). Erosion has been investigated at room temperature for erodents of varying hardness, impact angles between 15 and 90°, and velocities from 40 to 150 m/s. Results indicate that some toughening mechanisms are beneficial, whereas others are detrimental, to erosion resistance. Fabrication of the composites plays an important role in the erosion resistance.

30842 (CONF-8810352–, pp. 151-167) **Metal-matrix composites (technology update).** Ducati, U.; Donzelli, G.; Lenti, A.; Nuzzolo, D. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

Metal-matrix composites are being considered in the transport sector, especially by the aerospace industry, as an interesting alternative material for designs in which lightness and rigidity are of prime importance. This report provides an update on the knowledge that has been gained through fundamental research and testing. Brief notes are provided on current applications, fabrication methods, ceramic fibers, load transfer ot metal-fiber interface, current and future research program objectives.

30843 (ECN-I–90-5) **Oxidation enthalpy of $YBa_2Cu_3O_{6+y}$ in relation with phase behaviour and stoichiometry.** Verweij, H.; Bruggink, W.H.M.; Steeman, R.A.; Frikkee, E.; Helmholdt, R.B. Netherlands Energy Research Foundation, Petten (Netherlands). Jan 1990. 31p. Order Number DE90767905. Available from NTIS (US Sales Only), PC A03/MF A01.

Oxidation enthalpies for $YBa_2Cu_3O_{6+y}$ are derived from continuous equilibrium partial oxygen pressure curves, obtained with the constant-stoichiometry cooling technique in the temperature range of 350-950 C. Accurate stoichiometry data for high-purity single-phase $YBa_2Cu_3O_{6+y}$ samples in equilibrium with atmospheric O_2 were redetermined by thermogravimetric and neutron diffraction techniques. Phase behaviour was checked by means of high-temperature neutron diffraction experiments. Structural data for $YBa_2Cu_3O_{6+y}$ at 800 C in atmospheric O_2 are compared with those for a sample with the same stoichiometry at room temperature. It is found that the oxidation enthalpy of orthorhombic $YBa_2Cu_3O_{6+y}$ is independent of stoichiometry and temperature. For tetragonal $YBa_2Cu_3O_{6+y}$ a slight temperature dependence of the oxidation enthalpy is found, which is probably connected with a gradual ordering of oxygen atoms at decreasing temperatures. The oxidation enthalpy data in their relation with stoichiometry, temperature and phase behaviour give support for a localized description of the charge distribution in $YBa_2Cu_3O_{6+y}$. 4 figs., 22 refs., 4 tabs.

30844 (FRCEA-TH–254) **Deterioration study of a material for encapsulation of radioactive wastes, the Portland cement, by heterotrophic microorganisms isolated from natural media.** Perfettini, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI); Aix-Marseille-3 Univ., 13 - Marseille (France). 1989. 201p. (In French). Order Number DE90784615. Available from NTIS (US Sales Only), PC A10/MF A01.

Soils and geologic formations selected for storage of radioactive waste storage contain microflora (nitrifying and sulfoxidizing bacteria, heterotrophic microorganisms) that can corrode cement through acidic metabolism products. Nutriments required for their development are also found in these biotopes. Corrosive effects of organic acids produced by heterotrophic microorganisms are: mass decrease, leaching (especially Ca), dissolution of portlandite crystals Ca $(OH)_2$, increase of porosity and decrease of flexural strength. Excretion of corrosive organic acids by bacteria is promoted by high temperature and basic pH. Acidification by fungi requires also a high temperature but an acidic pH.

30845 (FR-CEA-TH–261) **Local structure near actinides and nucleating elements in borosilicate glass for nuclear industry: Results of X-ray absorption spectroscopy.** Petit-Maire, D. CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France); Paris-6 Univ., 75 (France). 1988. 254p. (In French). Order Number DE90784632. Available from NTIS (US Sales Only), PC A12/MF A01.

Possibilities and limits of X-ray absorption spectroscopy for cation site description in silicate glasses and possible applications for complex glasses, like glass for fission product containment, are examined. In borosilicate glasses two types of sites are evidenced for actinides at the valence 4: Coordinance 6 sites with a narrow radial distribution for the distance An-0; higher coordination (7, 8 or more) with a wider and asymmetrical radial distribution. Proportion of low coordinance sites increases when cation size decreases (Th > Np). U and Np VI and V are characterized as actinyles with a chain 0-An-0 practically linear, coordinance in a plane perpendicular to this complex is probably 5. X-ray absorption spectroscopy allows an accurate description of actinide sites in fission product glasses.

30846 (K/QT–214) **The effects on vapor pressure and heat of vaporization of adding the liquid coolant C816 to the evaporative coolant R-114.** Barber, E.J. Oak Ridge Gaseous Diffusion Plant, TN (USA). Aug 1988. 35p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90010894. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The liquid coolants C816 (perfluorodimethylcyclohexane) [FC-c71(16)] and B437 (2,2,3-trichloroheptafluorobutane) (CFC-317a) are now surplus materials. The future availability of sufficient quantities of the evaporative coolant R-114 (1,2-dichlorotetrafluoroethane) (CFC-114) has been cast in doubt by the Montreal International Protocol, which regulates the production of chlorofluorocarbons, including R-114. To examine the possibility that the liquid coolant might be used to stretch the R-114 supply, the effects of adding small amounts of the liquid coolants, as exemplified by C816, to the R-114 were examined. When the coolant is removed from the cooler, a residual of about 32 lb (14.5 kg) of liquid that is principally C816 remains unless the cooler temperature is above ~116°F (46.7°C). There is an additional quantity of coolant in the vapor phase. If a cooler leak to the cell were to develop during a treatment, the partial pressure of the coolant could reach about 0.08 psia (550 Pa). The effects of such an incident will be explored in a supplemental report. Introduction of quantities of

these liquid coolants which exceed the allowable limits for fluorocarbons via small coolant leaks into the isotopic cascade could be a source of difficulty because all the current product removal systems are designed to eliminate only materials more volatile than UF_6 from product. This problem will be explored further in the supplemental report. This report suggests that a heat transfer study be made to estimate the cooler temperature that results from coolant removal from the system and how long it will take to remove the coolant. When these estimates and the results of the other supplemental studies are available, a decision as to the possibility of economically using the surplus liquid coolants for the suggested purpose can be made.

30847 (LA-UR-90-1310) **Ta and Nb reinforced $MoSi_2$: Revision 1.076.** Carter, D.H. (Los Alamos National Lab., NM (USA)); Martin, P.L. Los Alamos National Lab., NM (USA). 11 Apr 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900466-24: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010596. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

$MoSi_2$ matrix composites have been recognized lately as potential materials for structural applications at elevated temperatures. Specifically, $MoSi_2$ composites may exhibit useful properties at temperatures to 1400°C. Previous work improved the yield strength of $MoSi_2$ at 1400°C by a factor of five through SiC whisker reinforcement. Current research is directed towards increasing the fracture toughness of $MoSi_2$ through the addition of ductile phase reinforcements such as niobium and tantalum. The reaction between Nb and $MoSi_2$ to form $(Mo,Nb)_5Si_3$ proceeds with faster kinetics at hot isostatic press temperatures as low as 1100°C when compared to the reaction between Ta and $MoSi_2$ to form $(Mo,Ta)_5Si_3$. This reaction product exhibits very poor properties, as evidenced by crack propagation through this layer during fracture. The feasibility of hot working these composites to produce tailored microstructures is examined. 11 refs., 10 figs.

30848 (LA-UR-90-1368) **The mechanical properties of Cu/TiB_2 multilayer structures.** Hubbard, K.M.; Basu, S.N.; Hirvonen, J-P.; Jervis, T.R.; Nastasi, M. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900466-22: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010608. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have investigated the hardness and tribological properties of Cu/TiB_2 multilayer structures deposited on substrates of tempered martensitic steel. Films of Cu and TiB_2 were also deposited as hardness standards. The wear properties of the films were found to be poor, because of lack of adhesion. However, the films do appear to have good fracture toughness. The hardness of the multilayer was 20% greater than that predicted by the law of mixtures applied to the reference standards and, when corrected for variations in substrate hardness, very nearly equal to that of the TiB_2 film. Irradiation by 400 keV Ne-ions to doses of 1.0, 6.0, and 12 x 10^{15} ion/cm^2 results in a slight hardening of the multilayer. The structure was found to have excellent stability against radiation damage. 13 refs., 4 figs.

30849 (LA-UR-90-1373) **HREM defects in $GaAs/Ga_{1-x}In_xAs$ strained layer superlattices.** Unal, O.; Laurich, B.K.; Mitchell, T.E. Los Alamos National Lab., NM (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900466-23: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010610. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

$GaAs/Ga_{1-x}In_xAs$ strained layer superlattices with well-widths of 7nm, barrier widths of 14nm and periods of 10 to 30 have been examined by HREM both in plan view and cross section. Strain release occurs mostly by dislocation generation but twins are also observed, especially at the substrate interface. High resolution images of dislocations, twins and interfaces are analyzed to elucidate mechanisms of strain release. 5 refs., 7 figs.

30850 (MLM-3616(OP)) **Evaluations of internal density variations of plastic molded pieceparts.** Kaye, C.J. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-900439-1: 35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials, the challenge for the next decade, Anaheim, CA (USA), 2-5 Apr 1990). Order Number DE90010081. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Density variations were discovered in molded plastic pieceparts during routine radiographic inspection. These variations were investigated to determine their nature and their possible effect on part performance. Sectioning of the molded parts and analysis of the plastic flow during production indicated that the orientation and concentration of glass fibers in the part correlated to the observed density variations. Parts were then subjected to various physical strength, laboratory, and application environmental testing. While it was concluded that changes in the amount or severity of density variations should alert the molder to reexamine the molding parameters and material, all test results demonstrated that density variations were not detrimental to the physical properties, the design intent, or the functionality of the molded parts. 2 refs., 2 figs., 1 tab.

30851 (N-90-12659) **Tribological properties of PM212: A high-temperature, self-lubricating, powder metallurgy composite.** Dellacorte, C.; Sliney, H.E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 22p. (NASA-TM-102355;E-5066;NAS-1.15:102355;CONF-900588-: 45. annual meeting of the Society of Tribologists and Lubrication Engineers, Denver, CO (USA), 7-10 May 1990). Available from NTIS, PC A03/MF A01.

This paper describes a research program to develop and evaluate a new high temperature, self-lubricating powder metallurgy composite, PM212. PM212 has the same composition as the plasma-sprayed coating, PS212, which contains 70 wt percent metal-bonded chromium carbide, 15 wt percent silver and 15 wt percent barium fluoride/calcium fluoride eutectic. The carbide acts as a wear resistant matrix and the silver and fluorides act as low and high temperature lubricants, respectively. The material is prepared by sequential cold press, cold isostatic pressing and sintering techniques. In this study, hemispherically tipped wear pins of PM212 were prepared and slid against superalloy disks at temperatures from 25 to 850 C in air in a pin-on-disk tribometer. Friction coefficients range from 0.29 to 0.38 and the wear of both the composite pins and superalloy disks was moderate to low in the 10(exp -5) to 10(exp -6) cubic mm/N-m range. Preliminary tests indicate that the material has a compressive strength of at least 130 MPa over the entire temperature range of 25 to 900 C. This material has promise for use as seal inserts, bushings, small inside diameter parts and other applications where plasma-sprayed coatings are impractical or too costly.

30852 (PB-90-174392/XAB) **Inorganic composite materials in Japan: Status and trends.** Koczak, M.J.; Prewo, K.; Mortensen, A.; Fishman, S.; Barsoum, M. Office of Naval Research Liaison Office, Far East, APO San Francisco, CA 96503 (USA). Nov 1989. 61p. (ONRFE-M-7). Available from NTIS, PC A04/MF A01.

See also PB-89-230015.

Japan's high performance composite research activities and applications are reviewed by six authors who teamed as a study group in September 1988 to assess selected research areas of composite activities. The article focuses on metal and ceramic matrix composites and high temperature ceramic reinforcements, excluding carbon fibers and polymer matrix composites. It is the intention of the article to capture the current trends and scientific accomplishments of university, government research laboratories and, to a lesser extent, selected industrial laboratories in the research areas. In addition, an interpretation and forecast of future directions is considered in each topic area based on current activities and perceived trends.

30853 (PB-90-861915/XAB) **Recycling asphalt pavements. January 1975-January 1990 (a Bibliography from the COMPENDEX data base). Report for January 1975-January 1990.**

National Technical Information Service, Springfield, VA (USA). Mar 1990. 61p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the recycling of asphalt-containing pavement materials. Articles include examples of recycling asphalt pavements; performance testing of recycled paving; methods including cold in-place, cold off-site, and hot-mix recycling; additives in recycled pavement for better performance; use of scrap roofing asphalt in conjunction with recycled paving; economics of recycling; process design; and process variables. Recycling of other materials is considered in related bibliographies. (Contains 130 citations fully indexed and including a title list.)

30854 (SAND–90-0256C) **Tin doping of InSb grown by MOCVD using tetraethyltin.** Biefeld, R.M. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900562–3: Spring meeting of the Electrochemical Society, Montreal (Canada), 6-11 May 1990). Order Number DE90009727. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Tetraethyltin was investigated as an n-type dopant for InSb. Carrier concentrations between 6×10^{15} and 4×10^{18} cm^{-3} with 77 K mobilities ranging from 75,000 to 10,000 cm^2/Vs were achieved for Sn doped InSb. SIMS measurements indicate a diffusion coefficient for Sn in InSb at 470 C that is approximately 1×10^{-15} cm^2/s. Both Hall and SIMS measurements on Sn doped samples indicate that Sn in incorporated as an n-type dopant with no memory effect and no self compensation, making Sn a much better doping source than Te or Se. 9 refs., 4 figs.

30855 (SAND–90-0421) **Equilibrium swelling of elastomeric materials in solvent environments.** Green, P.F. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010164. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The equilibrium swelling of silicones, fluorosilicones, VITON and ethylene-propylene-diene (EPDM) elastomers in an environment of the jet fuel JP4 was investigated. The volume of silicone and DPDM elastomers increased by approximately 100% when they were placed in a saturated environment of JP4. Conversely, the volume of the fluorosilicone elastomer increased by approximately 15% and that of VITON less than 1%. In acetone, a commonly used solvent, the equilibrium swelling of VITON and the fluorosilicone elastomer was excessive, on the order of 100%, wheras the silicone and EPDM elastomers exhibited small changes in dimensions. Reasons for these observations are discussed in detail. We also present a simple scheme by which one may, qualitatively, determine the dimensional stability of these elastomers in different solvents if the cohesive energy density of the solvent, which is readily available in a number of handbooks, is known. We also evaluated the vulnerability of some commonly used engineering thermoplastics to JP4. The results are tabulated. 13 refs., 6 figs., 3 tab.

30856 (UCRL-JC–103521) **Microstructural dependence of aerogel mechanical properties.** LeMay, J.D.; Tillotson, T.M.; Hrubesh, L.W.; Pekala, R.W. Lawrence Livermore National Lab., CA (USA). 11 Apr 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–19: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010478. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Aerogels are highly porous solids derived from the hypercritical drying of covalently crosslinked gels. SEM, TEM and scattering studies reveal that these materials have an open-cell morphology with a solid matrix composed of interconnected colloidal-like particles. Processing variables and synthetic conditions largely determine the microstructure and morphology. In this study, the structure-mechanical property relationships of silica, resorcinol-formaldehyde, and carbon aerogels are examined. 13 refs., 2 figs.

30857 (UCRL-JC–103522) **A new synthetic route to organic aerogels.** Pekala, R.W.; Alviso, C.T. Lawrence Livermore National Lab., CA (USA). 11 Apr 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900466–18: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010477. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The aqueous, sol-gel polymerization of melamine with formaldehyde, followed by supercritical extraction, leads to the formation of a new type of organic aerogel. Synthetic conditions (e.g. reaction time, pH) affect the density, transparency, and microstructure of the resultant aerogels. Unlike previous organic aerogels based upon resorcinol-formaldehyde, the melamine-formaldehyde aerogels are both colorless and transparent. Low densities (0.1-0.8 g/cc), high surface areas (~1000 m^2/g), and optical clarity are only a few of the promising characteristics of this new material. 12 refs., 3 figs.

30858 Varational quantum Monte Carlo calculation of materials properties. Louie, S.G. (Dept. of Physics, Univ. of California at Berkeley, and Materials and Chemical Sciences Division, Lawrence Berkeley Lab. Berkeley, CA (US)). pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. Grant DMR88-18404. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

A new method of calculating the total energy and other ground-state properties of solids which employ nonlocal pseudopotentials in conjunction with the variational quantum Monte Carlo approach is presented. Valence electron correlations are treated using the exact interaction with a correlated many-electron wavefunction of the Jastrow-Slater form. The use of pseudopotentials for the electron-ion interaction removes from the problem the large fluctuations of electron energies in the core region which occur in quantum Monte Carlo all-electron schemes. The authors discuss calculation of the cohesive energy and structural properties of diamond and graphite and the ionization energy and electron affinity of atoms using the present approach. The results are in agreement with experiment.

30859 Measurement of the sound velocity in AlAs by picosecond utrasonics. Young, D.A. (Brown Univ., Providence, RI (US)); Grahn, H.; Maris, H.J.; Tauc, J.; Hong, J.M.; Smith, T.P. III. pp. 402 of Thin films: Stresses and mechanical properties. Bravman, J.C.; Nix, W.D.; Barnett, D.M.; Smith, D.A. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811222–: Thin films: stresses and mechanical properties, Boston, MA (USA), 28-30 Nov 1988).

Picosecond ultrasonics have been used to measure the sound velocity and index of refraction in a thin film of AlAs. The AlAs layer was grown by molecular-beam epitaxy on a buffer layer of GaAs which was deposited on a semi-insulating GaAs wafer. The AlAs film was capped by a thin layer of GaAs, and a very thin film of InSb. To generate a sound wave effectively a picosecond light pulse was absorbed in the InSb film. As the sound wave propagates through the microstructure it changes the optical properties in the various films, and this produces a change in the optical reflectivity, which is measured. From the round trip time of the acoustic wave the authors have determined the sound velocity in the AlAs film.

30860 Effect of temperature on the mechanical properties and microstructures of in situ formed Cu-Nb and Cu-Ta composites. Spitzig, W.A. (Ames Lab USDOE, Iowa State Univ, Ames, IA (US)); Krotz, P.D.; Chumbley, L.S.; Verhoeven, J.D.; Downing, H.L. pp. 383 of High temperature/high performance composites. Lemkey, F.D.; Strife, J.R.; Fishman, S.G.; Evans, A.G. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-7405-ENG-82. (CONF-8804181–: MRS: high temperature/high performance composites, Reno, NV (USA), 5-9 Apr 1988).

The effect of temperature on the mechanical properties and microstructures is evaluated for heavily cold drawn Cu-20% Nb and Cu-20% Ta composites. The strengths of the composites decrease with increasing temperature, with the decrease becoming most pronounced at temperatures above about 300 ^{degrees}C and at larger draw ratios. Cu-20% Ta composites are stronger than Cu-20% Nb composites throughout the temperature range studied (22-600^{degrees}C) with the improvement increasing with increasing temperature. Resistivity measurements and substructure analyses show that at temperatures where softening accelerated, resistivity decreased indicating a substructural change which was observed to be coarsening of the Nb and Ta filaments.

30861 Electronic structure of compensated dopants in hydrogenated amorphous silicon. Yang, L.H. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Fong, C.Y. pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

The authors use first principles pseudopotential method to study the electronic structures of compensated dopants in a realistic model of hydrogenated amorphous silicon. Boron and phosphorus atoms are treated as dopants. Two sites in the gap are identified as the boron-phosphorus pair related states. The lower energy state, strongly localized around the boron atom, is obtained when the atom has a hydrogen atom as a nearest neighbor. The local environment does not affect the localization feature of the state. Other environment around the boron atom cause the charge distribution to be more extended in space. The higher energy state having its charge around the phosphorus atom does not show, strong localization at the phosphorus atom.

30862 Explanation of the anomalously large defect-optical-absorption energies in doped amorphous silicon. Branz, H.M. (Solar Energy Research Inst., Golden, CO (US)). pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

The longstanding controversy over the anomalously large subgap optical absorption energies in n-type (1.1 eV) and p-type (1.3 eV) hydrogenated amorphous silicon (a-Si:H) is described and resolved. It has been suggested that these large values are incompatible with a positive effective correlation energy of the dangling bond defect and a 1.7 eV bandgap and proposed that dopant-defect pairing deepens each dangling bond transition energy by about 0.5 eV in doped a-Si:H. The author assumes no deepening due to pairing, a positive correlation energy of 0.2 eV consistent with the observation of dark electron spin resonance in undoped a-Si:H, and dangling-bond relaxation energies of 0.2 to 0.3 eV which are indicated by previous theoretical and experimental work. The postulate of vertical optical transitions then reduces the anomaly from about 0.9 eV to 0.4 eV. This residual anomaly may be explained by electronic-level deepening in doped a-Si:H caused by disorder-induced potential fluctuations of 0.2 eV half-width.

30863 Interfacial reactions between Co and GaAs. Shiau, F.Y. (Wisconsin Univ., Madison, WI (USA). Dept. of Metallurgical and Mineral Engineering); Zuo, Y.; Zheng, X.Y.; Lin, J.C.; Chang, Y.A. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988).

Interfacial reactions between Co and GaAs have been studies using bulk diffusion couples of Co (~0.5 mm thick)/GaAs and thin-film Co(~ – 40 nm) on (001) GaAs as well as the epitaxial formation of CoAs and CoGa on (001)GaAs. In addition, phase diagram of Co-Ga-As at 600 °C was determined. The thin-film results are rationalized in terms of the phase diagram and bulk diffusion data.

30864 Lithographic, photochemical and O_2 RIE properties of three polysilane copolymers. Taylor, G.N. (AT and T Bell Labs., Murray Hill, NJ (USA)); Hellman, M.Y.; Wolf, T.M.; Zeigler, J.M. pp. 450 of Advances in resist technology and processing V. MacDonald, S. A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8802123–: Advances in resist technology and processing V, Santa Clara, CA (USA), 29 Feb - 2 mar 1988).

The authors have examined the lithographic, photochemical and O_2 reactive ion etching (RIE) properties of three 50:50 mole% polysilane copolymers: poly(*i*-propylmethylsilane-co-*n*-propylmethylsilane), poly(cyclohexylmethylsilane-co-dimethylsilane), and poly(*i*-propylmethylsilane-co-phenylmethylsilane). All three behaved as positive resists when exposed to mid-UV or 248 nm light. The second polysilane mentioned exhibited the best overall properties: mid UV, 1.25 μm resolution and 450 mJ/cm^2 sensitivity; deep UV at 248.8 nm, 0.8 μm resolution and 260 mJ/cm^2 sensitivity. Exposure in either wavelength range affords bleaching of the long wavelength transition centered at 307 nm but does not appreciably alter the absorbance.

30865 Growth kinetics of grain-boundary induced melting: A molecular-dynamics study. . Phillpot, S.R. (Materials Science Div. Argonne National Lab.., Argonne IL (US)); Lutsko, J.F.; Wolf, D.; Yip, S. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The growth kinetics of melting nucleated at a high-angle twist boundary in silicon are investigated using molecular dynamics. Melting is found to be a two-stage process. In the first stage order is lost within a single plane at the interface and the density of the solid increases to that of the liquid. In the second stage the atomic coordination changes and an isotropic liquid is formed.

30866 Linear free energy relationships in glass corrosion. Abrajano, T.A. (Argonne National Lab., Argonne, IL (US)); Bates, J.K.; Bohlke, J.K. pp. 421 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

Various theoretical models that have been proposed to correlate glass durability to their composition for a wide variety of silicate, borosilicate, and aluminosilicate glasses are examined. Comparisons are made between the predictions of these models and those of an empirical formulation extracted from existing data in the present work. The empirical approach provides independent confirmation of the relative accuracy of the silica release rate predictions of the different theoretical models in static leaching systems. Extensions of the empirical approach used in this work are discussed.

30867 Valence hole localization in molecular auger decay. Lapiano-Smith, D.A. (Dept. of Chemistry, State Univ. of New York, Stony Brook, NY (US)); Ma, C.I.; Wu, K.T.; Hanson, D.M. pp. 642 of Chemical perspectives of microelectronic materials. Materials Research Society, Pittsburgh, PA (USA) (1989). Grant CHE-8703340. (CONF-8811223–: Chemical perspectives of microelectronic materials, Boston, MA (USA), 30 Nov - 2 dec 1988).

The authors discuss how studies of unimolecular decay, following the excitation of core electrons of the carbon and fluorine atoms in carbon tetrafluoride and silicon and fluorine in silicon tetrafluoride by monochromatic, synchrotron radiation, provide evidence for a valence bond depopulation fragmentation mechanism. The fragmentation processes were examined using time-of flight mass spectroscopy. The mass spectra show the distribution of ions collected in coincidence with low and high energy electrons. Distinct changes in the mass spectra with atomic site of excitation and photon energy are observed. The observation of F^{2+} ions in the time-of-flight mass spectra following excitation of a fluorine 1s electron in SiF_4 is significant because it provides direct evidence for the formation of a localized, two-hole, final valence state that persists on the time scale of fragmentation. In contrast, the lack of F^{2+} ions from CF_4, indicates that the fragmentation occurs through a delocalized two-hole state.

30868 Density dependence of the single-particle kinetic energy of solid hydrogen. Herwig, K.W. (Materials Research Laboratory and Department of Physics—University of Illinois at Urbana-Champaign, Urbana, Illinois 61801 (USA)); Gavilano, J.L.; Schmidt, M.C.; Simmons, R.O. *Physical Review, B: Condensed Matter (USA),* 41(1): 96-102 (1 Jan 1990). DOE Contract AC02-76ER01198.

We have measured the inelastic neutron scattering from solid parahydrogen at molar volumes from 23.2 to 17.0 cm^3. We observe peaks in the differential cross section $d^2\sigma/d\Omega\, dE$ corresponding to internal molecular transitions from ground to excited rotational and vibrational states. From the widths of these peaks we determine the center-of-mass translational energy per molecule using an

underlying Gaussian momentum distribution for the initial center-of-mass translational wave function. For volumes of 23.2, 21.3, 19.5, 18.2, and 17.0 cm^3/mole we find kinetic energies per particle of 77±3, 101±8, 122±14, 131±14, and 146±11 K, respectively.

30869 In-situ vitrification: Heat and immobilization are combined for soil remediation. . Fitzpatrick, V. (Geosafe Corp., Kirkland, WA (US)); Hansen, J. *Hazmat World (USA),* 2(12): 30-34 (Dec 1989).

This paper describes the ISV process which involves in-situ electric melting of contaminated solids at high temperatures, typically in the range of 1,600°C to 2,000°C. The possible dispositions of particular contaminants resulting from ISV processing include chemical or thermal destruction, removal from the treatment volume to the off-gas treatment system, and chemical or physical incorporation within the residual product.

30870 Critical micelle concentration behavior of sodium taurocholate in water. Meyerhoffer, S.M. (Duke Univ., NC (USA)); McGown, L.B. *Langmuir (USA),* 6(1): 187-191 (Jan 1990).

Fluorescent probes representing a wide range of aqueous solubility, including fluorescein isothiocyanate and four polycyclic aromatic hydrocarbon (PAH) compounds, were used to study the cmc behavior of sodium taurocholate (NaTC) in water. Fluorescence spectra, intensity, lifetimes, and anisotropy, as well as scattered light intensity, were measured as a function of NaTC concentration.

30871 Effects of high magnetic fields on charge-density waves in $NbSe_3$. Coleman, R.V. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901 (USA)); Everson, M.P.; Lu, H.; Johnson, A.; Falicov, L.M. *Physical Review, B: Condensed Matter (USA),* 41(1): 460-489 (1 Jan 1990). DOE Contract AC03-76SF00098.

The magnetotransport properties of $NbSe_3$ in the temperature range below the second charge-density-wave (CDW) onset of 59 K have been studied in magnetic fields up to 230 kG. At liquid-helium temperatures giant magnetoquantum oscillations caused by magnetic breakdown (MB) between the normal Fermi surface (FS) and open orbits on the nested sheets of the FS dominate the magnetotransport and are extremely sensitive to the pinned CDW configuration. Spatial variations in the phase of the pinned CDW change the local Fermi level and CDW gap, giving rise to a distribution of FS cross-sectional areas. These variations in FS cross section and CDW gap produce frequency shifts, amplitude modulations, and beat structures in the quantum oscillations observed in both the magnetoresistance and Hall effect. A model conductivity tensor has been developed describing the open-orbit network and MB interference as well as the closed-orbit contribution. The adjustable parameters of the model are the frequency of oscillation, the frequency-distribution spread ΔF, and critical MB parameter $\omega_0\tau$.

30872 Nonadiabatic adsorbate vibrational damping and surface electronic structure: H on W(001). Smith, K.E. (Department of Physics, University of Oregon, Eugene, Oregon 97403 (US)); Kevan, S.D. *Physical Review Letters (USA),* 64(5): 567-570 (29 Jan 1990). DOE Contract FG06-86ER45275.

Recent infrared-absorption measurements of the vibrations of hydrogen adsorbed on W(001) have provided unambiguous evidence for electronic damping of atomic vibrations on metallic surfaces. This is a simple example of nonadiabatic coupling of a discrete state to a continuum. We describe here selection rules and other criteria for nonadiabatic electronic dampling of adsorbate vibrations and report the observation and characterization, using angle-resolved photoemission, of a surface resonance close to the Fermi level on H-saturated W(001) which satisfies these criteria.

30873 Structure of a precursor state in dissociative chemisorption. McGrath, R. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974 (US)); MacDowell, A.A.; Hashizume, T.; Sette, F.; Citrin, P.H. *Physical Review Letters (USA),* 64(5): 575-578 (29 Jan 1990). DOE Contract AC02-76CH00016.

Near-edge– and surface-extended–x-ray-absorption fine-structure measurements of H_2S on Cu(001)$p(2\times2)$S have been used to make the first direct structural determination of an intermediate molecular precursor in dissociative adsorption. Our results indicate that population of these precursor states overcomes the kinetic barrier to H_2S adsorption and leads to the formation of a $c(2\times2)$S structure.

30874 Columnar microstructure and stress measurements in amorphous $W_{0.75}Si_{0.25}$ thin films. Thomas, R.E. (Materials Science Center, University of Wisconsin, Madison, Wisconsin 53706 (US)); Perepezko, J.H.; Wiley, J.D. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(2): 885-890 (Mar 1990). DOE Contract FG02-84ER45096.

Columnar microstructure has been observed in direct-current sputter deposited amorphous metal thin films of $W_{0.75}Si_{0.25}$. Transmission electron microscopy was used to examine the films, both in cross section and plan view. Individual columns are 50–150 A in diameter and the morphology is typical of a zone 1 structure. In contrast, films of the same composition deposited by magnetron sputtering did not exhibit a columnar microstructure. The dc sputtered films were also found to be in tensile stress when deposited on silicon substrates. Measured stresses ranged from 6.5×10^8 Pa for 4000 A films with a linear increase to 8×10^8 Pa for 33 000 A films. For films thinner than 4000 A the stress in the films dropped off rapidly. The linear increase in stress seen was attributed to mutual attractive forces between adjacent columns.

30875 High-resolution incoherent imaging of crystals. Pennycook, S.J. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (US)); Jesson, D.E. *Physical Review Letters (USA),* 64(8): 938-941 (19 Feb 1990). DOE Contract AC05-84OR21400.

A Bloch-wave analysis shows how a signal dependent on the electron intensity at the atom sites can be used to form an incoherent image of a crystal structure. To a good approximation the image is given by a convolution of a compositionally sensitive object function with an appropriate resolution function, and as such can be predicted and interpreted intuitively. Information on a scale below the resolution limit can be interpreted by deconvolution.

30876 Layer-by-layer melting of argon films on graphite: A neutron-diffraction study. Larese, J.Z. (Brookhaven National Laboratory, Upton, New York 11973 (US)); Zhang, Q.M. *Physical Review Letters (USA),* 64(8): 922-925 (19 Feb 1990). DOE Contract AC02-76CH00016.

Elastic neutron diffraction is used to study the melting of multilayer argon films physisorbed on a graphite substrate. The layers are found to disorder sequentially from the outermost layer of the film toward the graphite surface with the melting of individual layers occurring gradually over a temperature range of about 10°. For films initially two or more layers thick the melting of the layer closest to the substrate occurs near 100 K. Comparisons are made with recent computer simulations and with thermodynamic measurements.

30877 Structure and chemical composition of water-grown oxides of GaAs. Liliental-Weber, Z. (Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Wilmsen, C.W.; Geib, K.M.; Kirchner, P.D.; Baker, J.M.; Woodall, J.M. *Journal of Applied Physics (USA),* 67(4): 1863-1867 (15 Feb 1990). DOE Contract AC03-76SF00098.

Previously it has been shown that the electronic surface properties of GaAs can be improved by photochemical treatment in water. If this photowashing technique is carried out with intense white light, oxides several hundred angstroms thick can be grown. This paper reports the structure and composition of this photowashed oxide and one grown by soaking in stagnant water in low light. The oxide was determined by TEM cross sections to be highly porous, but with thin continuous oxide layers both at the surface and at the oxide/GaAs interface. The oxide is composed of Ga_2O_3 with a low concentration of As_2O_3. The layer is primarily a fine grain Ga oxide crystal with a structure which appears different from the common forms of Ga_2O_3.

30878 Potassium-assisted, facile oxidation of Si_3N_4 thin films. Blair, D.S. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (US)); Rogers, J.W. Jr.; Peden, C.H.F. *Journal*

of Applied Physics (USA), 67(4): 2066-2073 (15 Feb 1990). DOE Contract AC04-76DP00789.

X-ray photoelectron spectroscopy (XPS) was used to investigate potassium-assisted, facile oxidation of silicon nitride (Si_3N_4) thin films on Si(100) substrates. The nitride films, 0.8–2.5 nm thick, were grown by heating the Si(100) crystal in hydrazine. Potassium (K) deposited onto the Si_3N_4 surface at room temperature in a background of oxygen resulted in the formation of potassium peroxide (K_2O_2) overlayers. Annealing the sample at 975 K for only 60 s decomposed the K_2O_2 overlayer, desorbed K from the surface, and efficiently oxidized the underlying substrate. The XPS Si(2*p*) spectra indicate formation of silicon oxynitride on the surface. In the early stages of oxidation, up to 100% of the oxygen originally deposited as K_2O_2, was converted to silicon oxynitride after annealing. The enhanced oxidation rate under these conditions, relative to direct thermal oxidation, is attributed to the large concentration of reactive oxygen on the surface when the K_2O_2 thermally decomposes.

30879 Lattice parameter and nearest-neighbor distances in $Zn_{1-x}Fe_xSe$ ($0<x<0.22$). Qadri, S.B. (Naval Research Laboratory, Washington, DC 20375-5000 (US)); Kim, K.H.; Skelton, E.F.; Furdyna, J.K. *Journal of Applied Physics (USA)*, 67(4): 2156-2157 (15 Feb 1990).

Lattice parameters and nearest-neighbor distances have been measured for bulk grown $Zn_{1-x}Fe_xSe$ ($0\leq x\leq 0.22$) using standard x-ray diffraction and extended x-ray absorption fine structure techniques, respectively. The lattice parameters are in agreement with reported values for molecular beam epitaxy grown films, but differ slightly from published results for other bulk-grown samples. The nearest-neighbor distances suggest a slight distortion from the zinc-blende structure.

30880 High resolution studies of core electron excitations in $Ru_3(CO)_{12}$ and the effects of metallic screening. Sondericker, D.; Fu, Z.; Bradley, J.; Eberhardt, W. *Journal of Chemical Physics (USA)*, 92(4): 2203-2207 (15 Feb 1990).

High resolution electron yield spectra of core electron excitations in condensed $Ru_3(CO)_{12}$ exhibit a pronounced shoulder in the C $1s\rightarrow\pi^*$ excitation, due to transitions into unoccupied π levels consisting of linear combinations of the 2π orbitals of the various CO molecular ligands. The O edge near edge spectrum shows a clear and pronounced σ shape resonance transition, about 2 eV lower in energy than in free CO. We develop an intuitive model, which correlates the differences in the relaxation energies associated with the various core electron excitations with changes in the metal to ligand charge transfer process. The consequences of these differences in the core hole screening process with respect to standard models relating the position of the σ shape resonance to the bond length are discussed also.

30881 Electronic-carrier-controlled photochemical etching process in semiconductor device fabrication. Ashby, C.I.H.; Meyers, D.R.; Vook, F.L. To Dept. of Energy, Washington, D.C. USA Patent 4880493/A/. 14 Nov 1989. Filed date 16 Jun 1988. USA Patent Application 7-207,487–. Int. Cl. H01L 21/306. vp.

The patent describes an electronic-carrier-controlled photochemical etching process for carrying out patterning and selective removing of material in semiconductor device fabrication includes the steps of selective ion implanting, photochemical dry etching, and thermal annealing, in that order. In the selective ion implanting step, regions of the semiconductor material in a desired pattern are damaged and the remainder of the regions of the material not implanted are left undamaged. The rate of recombination of electrons and holes is increased in the damaged regions of the pattern compared to undamaged regions. In the photochemical dry etching step which follows ion implanting step, the material in the undamaged regions of the semiconductor are removed substantially faster than in the damaged regions representing the pattern, leaving the ion-implanted, damaged regions as raised surface structures on the semiconductor material. After completion of photochemical dry etching step, the thermal annealing step is used to restore the electrical conductivity of the damaged regions of the semiconducto

30882 Water soluble conductive polymers. Aldissi, M. To Dept. of Energy, Washington, DC. USA Patent 4880508/A/. 14 Nov 1989. Filed date 3 Apr 1989. USA Patent Application 7-331,776. Int. Cl. C25C 11/00. 8p.

This patent describes polymers which are soluble in water and are electrically conductive. The monomer repeat unit is a thiophene or pyrrole molecule having an alkyl group substituted for the hydrogen atom located in the beta position of the thiophene or pyrrole ring and having a surfactant molecule at the end of the alkyl chain. Polymers of this class having 8 or more carbon atoms in the alkyl chain exhibit liquid crystalline behavior, resulting in high electrical anisotropy. The monomer-to-monomer bonds are located between the carbon atoms which are adjacent to the sulfur or nitrogen atoms. The number of carbon atoms in the alkyl group may vary from 1 to 20 carbon atoms. The surfactant molecule consists of a sulfonate group, or a sulfate group, or a carboxylate group, and hydrogen or an alkali metal. Negative ions from a supporting electrolyte which may be used in the electrochemical synthesis of a polymer may be incorporated into the polymer during the synthesis and serve as a dopant to increase the conductivity.

30883 Combustion synthesis of boride and other composites. Halverson, D.C.; Lum, B.Y.; Munir, Z.A. To Dept. of Energy, Washington, DC. USA Patent 4879262/A/. 7 Nov 1989. Filed date 28 Jul 1988. USA Patent Application 7-225,413. Int. Cl. C04G 35/52. 8p.

This patent describes a self-sustaining combustion synthesis process for producing hard, tough, lightweight B_4C/TiB_2 composites. It is based on the thermodynamic dependence of adiabatic temperature and product composition on the stoichiometry of the B_4C and TiB_2 reactants. For lightweight products the composition must be relatively rich in the B_4C component. B_4C-rich composites are obtained by varying the initial temperature of the reactants. The product is hard, porous material whose toughness can be enhanced by filling the pores with aluminum or other metal phases using a liquid metal infiltration process. The process can be extended to the formation of other composites having a low exothermic component.0:008360his patent describes a neutron reactivity control system for a LWBR incorporating a stationary seed-blanket core arrangement. The core arrangement includes a plurality of contiguous hexagonal shaped regions. Each region has a central and a peripheral blanket area juxapositioned an annular seed area. The blanket areas contain thoria fuel rods while the annular seed area includes seed fuel rods and movable thoria shim control rods.

40 CHEMISTRY

30884 (ANL–90/11) **Chemical Technology Division annual technical report 1989.** Argonne National Lab., IL (USA). Mar 1990. 227p. Sponsored by U.S. DOE Energy Research; U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. Order Number DE90008242. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

Highlights of the Chemical Technology (CMT) Division's activities during 1989 are presented. In this period, CMT conducted research and development in the following areas: (1) electrochemical technology, including high-performance batteries (mainly lithium/iron sulfide and sodium/metal chloride), aqueous batteries (lead-acid and nickel/iron), and advanced fuel cells with molten carbonate and solid oxide electrolytes: (2) coal utilization, including the heat and seed recovery technology for coal-fired magnetohydrodynamics plants and the technology for fluidized-bed combustion; (3) methods for recovery of energy from municipal waste and techniques for treatment of hazardous organic waste; (4) nuclear technology related to a process for separating and recovering transuranic elements from nuclear waste and for producing ^{99}Mo from low-enriched uranium targets, the recovery processes for discharged fuel and the uranium blanket in a sodium-cooled fast reactor (the Integral Fast Reactor), and waste management; and (5) physical chemistry of selected materials in environments simulating those of fission and fusion energy systems. The Division also has a program in basic chemistry research in the areas of fluid catalysis for converting small molecules to desired products; materials chemistry for superconducting oxides and associated and ordered solutions at high temperatures; interfacial processes of importance to corrosion science, high-temperature superconductivity, and catalysis;

and the geochemical processes responsible for trace-element migration within the earth's crust. The Division continued to be administratively responsible for and the major user of the Analytical Chemistry Laboratory at Argonne National Laboratory (ANL).

30885 The excitement of analytical chemistry in a multipurpose national laboratory. Shults, W.D. (Oak Ridge National Lab., TN (USA)). pp. 400000 of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331--: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 775.

The author suggests that there is a need to attract bright young people to chemistry, give them strong training in the fundamental principles of chemistry, provide basic laboratory skills that blend into proficiency with instrumentation, and then instill in them the desire to collaborate with others on work that has real significance. In a sense, the need is to develop chemists with an outward look. The author maintains that part of the excitement of analytical chemistry at a large multipurpose research laboratory is that it offers many of the opportunities cited above. There are all sorts of opportunities to collaborate within chemistry and with other disciplines. Programs of national and international significance abound. The challenges are such that analytical chemistry must be strong, diverse, state-o-the-art. Accordingly, national laboratories offer students the opportunity to see real-life analytical chemistry in action and to be a part of it. It is concluded that more should be done to exploit this resource.

4001 Analytical and Separations Chemistry

Refer also to citation(s) 29975, 29979, 29988, 30098, 30101, 30102, 30111, 30115, 30140, 30350, 30721, 30726, 30804, 30932, 30933, 31299, 31300, 31548, 31549, 31715, 31900

30886 (CNIC–00109) **Determination of trace As and Sb in geological samples by hydride atomic fluorescence method.** Chen Zhichang; Tang Liangfang. China Nuclear Information Centre, Beijing, BJ (China). 1987. 7p. (In Chinese). (NIC–0001). Order Number DE90626019. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

An experimental study of all parameters of As and Sb for hydrogenation and the influence of 20 coexistent ions and more on measuring As and Sb was conducted by atomic fluorophotometer of WFY-II type made in Wenzhou Instrument Factory, by microwavestimulated electrodeless discharge lamp as light source and by high-temperature quartz-tube furnace as atomizer. It is discovered that in the presence of a great number of Ni, Cu and heavy-metal ions the fluorescent signal decreased, and under the participation of sulfourea-antiscorbutic acid-mixed latent-agent the influence may be eliminated. The method to detect As and Sb by hydride-atomic fluorescence in a portion of the same sample solution was made up. The detection limits (2 σ): As and Sb are 1.28 x 10^{-10} g/m and 6.92 x 10^{-10} g/ml, respectively; The coefficients of variation of the method are 1.97% for As and 1.56% for Sb. According to the test results of 8 standard samples of drainage sediments (GSD) collected by the Geological Ministry, the quality is in accord with the demands.

30887 (CNIC–00157) **Determination of chlorine in nuclear-grade uranium compounds.** Yang Chunqing (Ministry of Nuclear Industry, Beijing, BJ (China). Research Inst. of Uranium Ore Processing); Liu Fuyun; Huang Dianfan. China Nuclear Information Centre, Beijing, BJ (China). Jan 1988. 7p. (In Chinese). (BRIUOP–0007). Order Number DE90626020. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The determination of chlorine in nuclear-grade uranium compounds is discribed. Chlorine is separated from uranium oxide pyrohydrolytically with stream of wet oxygen in a furnace at 800 $\approx$ 900 deg C. Chlorine is volatilized as hydrochloric acid, absorbed in a dilute alkaline solution and measured with chlorine-selective electrode. This method covers the concentration range of 10 $\approx$ 500 pm chlorine in uranium oxide. Precision of at least $\pm$ 10% and recovery of 85 $\approx$ 108% have been reported.

30888 (CNIC–00172) **Application of dual-wavelength spectrophotometry to the uranium ore analysis: The interference of calcium can be eliminated in the direct determination of uranium with arsenazo III by spectrophotometric method.** Jin Wenlong; Yao Mingxia; Yin Zinan; Guo Hancheng. China Nuclear Information Centre, Beijing, BJ (China). Mar 1988. 6p. (In Chinese). (UMRI–0003). Order Number DE90626021. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In the buffer solution (pH 2.2) with citric acid and sodium hydrogen phosphate, the uranium in ores can be directly determined with arsenazo III by dual-wavelength spectrophotometric method when Triethylenetetraminehexaacetic acid, diethylenetriaminepentaacetic acid and maleic acid are added as masking agents. The measuring wavelength and referential wavelength are 653.0 nm and 607.5 nm respectively. The interference of calcium can be fully eliminated because of its equivalent absorbance at these two wavelengths. The method is simple and rapid. The coefficient of variation (n=5) is less than 5% for 0.06% $\approx$ 0.5% of uranium in five certified reference materials. The values obtained for U agree with the certified values.

30889 (CNIC–00178) **Development of microporous mixed cellulose ester film and its application in chemical analysis.** Gan Xuanji (Ministry of Nuclear Industry, Beijing, BJ (China). Beijing Inst. of Uranium Geology); Xiao Deming; Liu Zhonghui; Wang Shujun. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 7p. (In Chinese). (BUGRI–0001). Order Number DE90626040. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Microporous mixed cellulose ester films with various chelating groups are good separation films for extraction. They are used as special analytical films. They can be used in 'solid-liquid' extractive procedure. By this way, the unification of samples preparation and separation procedures is effected. So it is a simple, quick, low cost method and eliminates harmful solvents. With the help of X-ray firorescence analysis, this method will be used as a new means applicable in trace analysis. With the application of different films and extractive conditions, this method is applicable in biological, environmental and geological analysis. In the mode of separation, it is simple to handle and required low background, low detection limit and with good accuracy.

30890 (CNIC–00185) **Determination of bromide in nuclear-grade uranium compounds.** Yang Chunqing (Ministry of Nuclear Industry, Beijing, BJ (China). Research Inst. of Uranium Ore Processing); Liu Fuyun; Huang Dianfan. China Nuclear Information Centre, Beijing, BJ (China). Mar 1988. 8p. (In Chinese). (BRIUOP–0008). Order Number DE90626022. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The determination of bromide in nuclear-grade uranium oxide is described. The method involves a separation of uranium from $UO_2(NO_3)_2$ solution by passing the sample through a silver-form cation exchange resin column. The bromide is then eluted from this column with ammonium hydoxide. The resulting solution is oxidied with sodium hypochlorite and reacts with fuchsine to form a purple-red complex. This colour solution is measured by spectrophotometry. This method determines bromide of 2.5 $\approx$ 1.50 ppm in uranium oxide. The precision is better than $\pm$ 10% and recovery is 89 $\approx$ 112%.

30891 (ECN–89-185) **Leaching behaviour of waste and stabilized waste materials: Characterization for environmental assessment purposes.** Van der Sloot, H.A. Netherlands Energy Research Foundation, Petten (Netherlands). Dec 1989. 29p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

The importance of systematic trends in trace contaminant leaching from waste materials and stabilized waste is stressed. Similarities in leaching behavior of different waste materials and mechanisms for leaching from stabilized waste forms are identified. The use of diffusion measurements to quantify the mobility of specific chemical species in waste and soil is discussed. Implementation of more fundamental regulatory testing procedures which reflect the behavior of materials in end use applications, is recommended to allow better control over environmental impact in the wide variety of utilization and disposal practices. 10 figs., 15 refs.

30892 (ECN–89-191) **Leaching characteristics of anorganic components from building materials in which primary and secondary materials are processed.** Van der Sloot, H.A.; De Groot, G.J.; Wijkstra, J.; Van der Wegen, G. Netherlands Energy Research Foundation, Petten (Netherlands). Dec 1989. 31p. (In Dutch). Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

Within the framework of the so-called 'MAMMOET' study building materials with primary and secondary basic materials were prepared by INTRON BV. The same secondary materials were used for a number of different building materials, which made it possible to compare the products. The primary materials are all based on cements. The secondary materials are neutral and alkaline fly ash of pulverized coals combustion, incineration slags and fly ash of three different incineration systems. The products obtained by using secondary materials and the reference products with primary materials are subjected to leaching tests by the Netherlands Energy Research Foundation (ECN) to quantify the emission of potentially hazardous anorganic elements or components. In particular the leaching mechanism has been studied in order to predict long-term impacts. The basic materials, products and leachates were analyzed for a large number of elements: Ca, Na, K, P, sulfates, As, Ba, Cd, Cl, Cr, Cu, F, Hg, Mo, Ni, Pb, Sb, Se, Sn, V and Zn. Based on some examples the leaching system of anorganic elements from building materials has been illustrated. Knowledge of the leaching system offers perspectives to standardize leaching tests and to formulate environmental certificates for building materials of primary and secondary materials. 16 figs., 17 refs., 6 tabs.

30893 (IAEA-AL–010) **Report on the intercomparison run IAEA-153 trace elements in milk powder.** Strachnov, V.I.; Schelenz, R.F.W.; Dekner, R.; Zeiller, E.; Burns, K. International Atomic Energy Agency, Seibersdorf (Austria). Analytical Quality Control Services. May 1989. 105p. Order Number DE90626023. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The recognition of the important role that inorganic constituents play in human nutrition and health has generated interest in establishing their concentration in foodstuffs and especially in milk powder. For this reason and the fact that these results may be the basis upon which economic, environmental, medical, legal and/or human health related decisions are made, it is important to be able to determine the concentration of the inorganic components with good precision and accuracy. In support of the need for international standards on foodstuffs, the Analytical Quality Control Services of the International Atomic Energy Agency periodically organizes international comparisons for the determination of inorganic constituents in milk powder. The comparison reported here is one in these series. One goal of this intercomparison was to continue investigation for multielement analysis to provide the participating laboratories with the opportunity of checking their analytical performance while at the same time establishing the concentration of some elements for certification purposes. Refs and tabs.

30894 (IAEA-AL–022) **Report on the re-evaluation of reference material A-14, K-40, Sr-90, Cs-137, Ca, K, Na in milk powder.** Strachnov, V.; Schelenz, R.; Dekner, R.; Burns, K. International Atomic Energy Agency, Seibersdorf (Austria). Analytical Quality Control Services. Oct 1989. 13p. Order Number DE90625995. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The original certification of IAEA milk powder A-14, based on open intercomparison, was issued in 1983. The material appears to be homogeneous and is reasonably well characterized for a number of mineral components and radionuclides. Samples of this milk powder have received widespread distribution and can still be supplied from stock. The main purpose of this new intercomparison run was to improve the existing data on this material and generate new analytical data for other components in this sample. The A-14 milk powder was sent to laboratories which took part in intercomparison runs IAEA-152 (Radionuclides in milk powder) and IAEA-154 (Radionuclides in whey powder) for analysis of four radionuclides (^{40}K, ^{90}Sr, ^{134}Cs, ^{137}Cs). Participating laboratories were requested to determine the following radionuclides: ^{40}K, ^{90}Sr, ^{134}Cs and ^{137}Cs and also encouraged to provide data on other radionuclides. The analysts were requested to make at least three but preferably six independent measurements for each radionuclide. Each laboratory received one bottle of A-14. The results listed in the tables are from 28 laboratories in 16 different countries. The re-evaluation was based on 51 laboratory means. The total number of individual determinations was 166. Nineteen laboratories determined ^{137}Cs, 21 determined ^{40}K and 14 determined ^{90}Sr. Since only very limited data were received for ^{134}Cs, this result has not been included in this report. Tabs.

30895 (IAEA-AL–026) **Report on the intercomparison run IAEA-321 radionuclides in milk powder.** Strachnov, V.; Burns, K.; Dekner, R. International Atomic Energy Agency, Seibersdorf (Austria). Analytical Quality Control Services. Jan 1990. 21p. Order Number DE90625997. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report contains the results of the intercomparison IAEA-321 on the determination of radionuclides in milk powder. Initially participants were requested to determine the levels of ^{134}Cs, ^{137}Cs, ^{40}K, ^{90}Sr and invited to provide data for other radionuclides. The participants included 61 laboratories located in 29 countries, and statistical evaluation of their data yield recommended values for these four radionuclides. Additional radionuclides reported were ^{226}Ra and ^{232}Th, however insufficient data exists to statistically determine recommended values for these radionuclides. The recommended values for radionuclide determination are: ^{134}Cs: 15.5 Bq/kg; ^{137}Cs: 72.6 Bq/Kg; ^{40}K: 552 Bq/kg; ^{90}Sr: 3.3 Bq/kg. Tabs.

30896 (RCM–01089, pp. 22-47) **Speciation of aquatic actinide ions by pulsed laser spectroscopies.** Klenze, R.; Kim, J.I.; Wimmer, H. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Dec 1989. Contract CEC FI 1W-0202-D. In *Thermodynamics and speciation: Carbonate complexation of Am(III) and speciation of actinides by pulsed laser spectroscopies. Progress report for the CEC project MIRAGE II.* Order Number DE90785156. Available from NTIS (US Sales Only), PC A04/MF A01.

Speciation capabilities of different pulsed laser spectroscopies are presented with particular examples of each speciation procedure. The methods under discussion are laser-induced photoacoustic spectroscopy (LPAS), time resolved laser-induced fluorescence spectroscopy (TRLFS) and photoacoustic detection of light scattering (PALS). The LPAS operation has been improved by introducing a dual beam single detection method for improved background compensation and a calibration method using a reference standard solution. The principle of PALS for the quantification of colloids in natural groundwater is discussed briefly. TRLFS is applied to the speciation of Cm(III) in $HClO_4$, EDTA, $NaHCO_3$, Na_2CO_3 and natural groundwater using their excitation and emission spectra and life time measurement. (orig.).

30897 (SNV–3629) **Determination of trace metals in natural fresh waters: Routines for increasing the precision.** Holm, K.; Borg, H.; Korhonen, M. Statens Natuurvaardsverk, Solna (Sweden). Jun 1989. 23p. (In Swedish). Order Number DE90626004. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The determination method still most widely used is atomic absorption spectrometry with graphite furnace. The natural levels of several elements are however too low to be accurately determined without any preconcentration. Besides, in sea water, the high salt content causes matric effects, which require time consuming separation steps as solvent extraction or ion exchange. The report describes two procedures for preconcentration of fresh water samples, freeze-drying and replicate injections in the furnace, respectively. The procedures are designed to be used on a routine basis. All water samples are collected in polypropylene bottles which are soaked before use in HCl 1+1, rinsed and allowed to stand until use filled with 0.1 M HNO_3. The samples are preserved by addition of conc. HNO_3 (2 ml/l, sub boiling distilled). In the freeze-drying procedure, the samples are weighed and frozen in the pre-weighed polypropylene sampling bottles and evaporated to about one tenth of the original volume in the vaccum chamber of a freeze dryer. The samples are then weighed again for determination of the concentration factor and alayzed by graphite furnace AAS. When using the other procedure, the water samples are directly injected into the frunace for several times (2-8) before atomization and measurement of the absorption signal. The drying and ashing

step is allowed to proceed after every injection. Comparisons of the two procedures have shown good agreement. The advantage of the replicate injection technique is primarily that the concentration factor is more esily controlled and repeated than by the freeze drying procedure. Further, the latter procedure sometimes suffers from precipitates being formed during the evaporation,especially in humic waters rich in iron. (12 figs., 7 tabs., 14 refs.).

30898 Supercritical fluid extraction-gas chromatography of pyrene from coal fly ash fractions. Mauldin, R.F. (Tennessee Univ., Knoxville, TN (USA). Dept. of Chemistry); Wehry, E.L.; Mamantov, G. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 744.

Supercritical Fluid Extraction-Gas Chromatography (SFE-GC) is growing rapidly as an on-line extraction-quantitation method of analysis. This technique reduces sample handling steps between extraction and quantitation, is usually performed at mild extraction temperatures, and has been reported to provide enhanced extraction recoveries when compared to traditional extraction methods. The presence of carbonaceous particles in coal fly ash has been determined to be the primary reason for the high affinity of PAH for fly ash surfaces. Similarly, low extraction efficiencies and low photoreactivities of adsorbed PAH have been observed on coal fly ashes that are high in carbon content. Therefore, a high carbon ash (75–125 μm) has been separated into a high carbon fraction (67.3% C) and a low carbon fraction (0.87% C) by solvent density and elutriator separation. The results of a study examining the extractability of vapor-deposited pyrene from these two fractions is discussed. Extraction efficiencies are presented for SFE and CO_2, SFE with CO_2 and methanol modifier, soxhlet extraction with methanol, and ultrasonic extraction with toluene. Also, data concerning the photoreactivity of pyrene adsorbed on these fractions is included in this this presentation.

30899 Direct thermal desorption ms/ms analysis of selected organophosphonates with an ion trap spectrometer. Igner, R.H. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.); Wise, M.B.; Buchanan, M.V. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 885.

Concern bout organophosphonates escaping into the environment during incineration has prompted the development of new air monitoring techniques capable of reliable analysis of these analytes at low picogram (pg), levels. Air quality monitoring often involves air sampling on a trapping material with subsequent thermal desorption of the analyte components onto a GC column for the separation of the analyte(s) prior to selective detection with a mass spectrometer. Utilizing the MS/MS capability of an ion trap mass spectrometer (ITMS), thermally desorbed components can be purged directly into an ITMS without an intermediate separation step. Selection of characteristic daughter ions allows analyte detection in the presence of other compounds or considerable background. This study involved the development of an automated thermal desorption unit and methodology for interfacing directly with a Finnigan ITMS. The design of the automated thermal desorption unit is very reliable due to the mechanically simple design which features few moving parts. Also, sample turnaround time is under 2 minutes for organophosphonates, thus addressing the need for rapid analysis of a large number of samples.

30900 Magnetic resonance imaging of ceramics. Ellingson, W.A. (Argonne National Lab., IL (USA). Materials and Components Technology Div.). vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 613b.

High-performance structure ceramic materials, usually of Si_3N_4 or SiC, are being developed for applications in advanced heat engines and high-temperature heat recovery systems. Various organic materials are used in the processing of these ceramics, e.g., polymer-based binders/plasticizers (B/Ps) in injection molding and water-based B/Ps in slip casting. The distribution of these organic materials in the initial forming stages strongly influences the final mechanical properties and flaw population. In the case of injection molding, many problems have been attributed to poor distribution of organic B/P. Examples are large pores caused by pockets of B/P left by incomplete mixing; cracks caused by improper extraction of B/P; and incomplete parts caused by improper feed material with poor B/P distribution. Magnetic resonance imaging with proton signals is a potentially useful technique for mapping the distribution of organic materials throughout an unfired part volume. However, the polymer-based B/Ps used in injection molding have very short T_2s, and corresponding broad spectral line widths. Consequently, data acquisition for imaging is difficult and special techniques must be used if typical spin-echo imagining is used with phase encoding. The authors have used a specially designed probe with self-shielded gradient coils to image the B/P at room temperature.

30901 Cross-linking stationary phases for gas chromatography by exposure to low-temperature plasmas. Springston, S.R. (Brookhaven National Lab., Upton, NY (USA). Environmental Chemistry Div.); Dezaro, D.A. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1036.

Many recent developments in capillary gas chromatography have focussed on techniques for cross-linking stationary phases. Cross-linking enhances the physical stability of polar films at higher temperatures by increasing the viscosity of the liquid phase. Properly cross-linked stationary phases also resist dissolution by large solvent injections. Thermal decomposition of free-radical initiators, such as azo compounds or organic peroxides, is a popular approach for achieving these goals. However, heating may disrupt marginally stable films before they are successfully cross-linked. In addition, chemical agents, particularly peroxides, cause undesirable polar decomposition products to be incorporated within the phase. Low-temperature plasmas were explored as a source of free radicals for the treatment of stationary phases. Plasmas can be controlled to minimize surface heating. Low pressures and pure reagent gases should minimize the presence of unwanted byproducts. Various polymers were deposited on microscope coverslips and exposed to an argon plasma (P = 1 torr). The treated films subsequently resisted solvent dissolution and were judged to be fully cross-linked. Similarly, SE-30 coated on glass beads was also rendered insoluble by plasma treatment. Chromatographic tests showed that both the polarity and the separation power were virtually unaffected by plasma exposure. Plasmas have also been generated within coated capillary columns. *In situ* cross-linked phases resisted solvent rinses. The chromatographic behavior of several different stationary phases is discussed.

30902 Calibration of volumetric flasks with use in an analitical chemistry variation laboratory. Weissman, S.H. (Sandia National Labs., Albuquerque, NM (USA)); Pace, C.F.; Thomas, E.V. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1131.

Most analytical chemistry laboratories use volumetric glassware to prepare solutions for quantitative analyses. Tolerance limits for volumetric flasks have been set by the National Institute of Standards and Technology (NIST). Class A glassware has the tightest tolerances. Typically, volumetric flasks are used with little prior knowledge of age or history of prior use. The glassware is generally cleaned but is not calibrated. Errors in volumetric flask

calibration will be propagated throughout an entire analysis, biasing the results. As part of an analysis in which high accuracy was needed, used class A glassware was calibrated prior to use. Neither age nor history of use was known. For ten 100 mL flasks, six were no longer within the tolerance of ±0.08 mL. Whether or not they were within the tolerances when new is unknown. Therefore, the authors initiated a study to look at the volumetric calibration of glassware as purchased and as a function of use. Experimental variables included brand, vendor, calibration method, analyst, and treatment. Twenty-four new 50 mL class A (±0.05 mL) volumetric flasks were cleaned, and subsequently calibrated using the gravimetric technique developed by NIST. Next, each was calibrated by three different analytical chemists using similar gravimetric methods. Following the calibration the flasks were divided into four groups: a control group, a group which received a mild soaking/mild cleaning treatment, a group which received a rigorous soaking/rigorous cleaning treatment, and a group which was used in routine analytical chemistry solution preparation. Calibration of the new flasks following initial cleaning showed that the volume of one flask was outside of the tolerance; containing 50.185 mL as determined by the chemistry laboratory. The volume of three other flasks were slightly less than the acceptable volume by one analyst's measurements.

30903 A device for performing surface-plasmon-polariton-assisted Raman scattering from adsorbates on single-crystal silver surfaces. Byahut, S. (Physics Department, Colorado School of Mines, Golden, Colorado 80401 (US)); Furtak, T.E. *Review of Scientific Instruments (USA),* 61(1): 27-32 (Jan 1990). DOE Contract FG02-86ER45253.

We describe the theory, design, and performance of a new surface-plasmon-polariton-(SPP) assisted Raman scattering instrument that exploits the Kretschmann geometry. In contrast to previous methods, our device allows the entire SPP emission cone to be collected, thus optimizing the detected Raman intensity. This advantage makes surface Raman scattering from adsorbates on relatively smooth or single-crystal silver films possible with routine optics and electronics in the rest of the system. We demonstrate the concept with data acquired from a monolayer of paranitrosodimethylanaline (pNDMA) on nearly smooth polycrystalline Ag and single-crystal Ag(111) with air or liquid as the ambient medium.

30904 Improved data acquisition and smoothing methods in high-resolution electron energy loss spectroscopy. Chen, P.J. (Surface Science Center, Department of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania 15260 (US)); Colaianni, M.L.; Yates, J.T. Jr. *Journal of Vacuum Science and Technology, A (Vacuum, Surfaces and Films) (USA),* 8(2): 764-768 (Mar 1990).

A simple method for converting an analog high-resolution electron energy loss (HREEL) spectrometer to a digital instrument is described in this paper. Methods of Fourier transform smoothing of the digital data are described and a comparision to RC-smoothed analog data is made using synthetic analog data. The advantages of digital data acquisition in HREELS compared to analog methods are presented.

30905 Portable system and method combining chromatography and array of electrochemical sensors. Zaromb, S.; Stetter, J.R. To U.S. Dept. of Energy, Washington, DC. USA Patent 4888295/A/. [1990]. Filed date 2 Jul 1986. USA Patent Application 6-881,310. Int. Cl. G01N 30/78. vp.

This patent describes a system for analyzing a fluid sample including mixtures of components. The system comprising: chromatographic apparatus for achieving time-spaced separation of components of the sample. The chromatographic apparatus including a chromatographic column having an inlet and an outlet, means for introducing a carrier fluid to the inlet of the column, and means for introducing a fluid sample to the inlet of the column; detection means communicating with the outlet of the column for identifying and estimating the concentration of the components eluting from the column. Also described is a method for analyzing a fluid sample including mixtures of components. The method comprising the steps of: passing the fluid sample through a chromatographic column for achieving time-spaced separation of components of the sample eluting from the column, introducing the eluted components to an array of sensors including plural electrochemical sensors having differing electrochemical responses to a given one of the eluted components or to a derivative thereof dependent upon the chemical interaction of the component or a derivative thereof with each of the sensors, operating on the component so as to selectively alter the response thereto by the sensors, arranging all of the responses of all of the sensors in the array of sensors into a response pattern and comparing the formed response pattern with a set of previously established response patterns to identify the component.

30906 Multiplexed electronically programmable multimode ionization detector for chromatography. Wise, M.B.; Buchanan, M.V. To Dept. of Energy, Washington, DC. USA Patent 4879472/A/. 7 Nov 1989. Filed date 19 May 1988. USA Patent Application 7-196,693. Int. Cl. G01N 27/70. 14p.

This patent describes method and apparatus for detecting and differentiating organic compounds based on their electron affinity. An electron capture detector cell (ECD) is operated in a plurality of multiplexed electronically programmable operating modes to alter the detector response during a single sampling cycle to acquire multiple simultaneous chromatograms corresponding to each of the different operating modes. The cell is held at a constant subatmospheric pressure while the electron collection bias voltage applied to the cell is modulated electronically to allow acquisition of multiple chromatograms for a single sample elution from a chromatograph representing three distinctly different response modes. A system is provided which automatically controls the programmed application of bias pulses at different intervals and/or amplitudes to switch the detector from an ionization mode to the electron capture mode and various degrees therebetween to provide an improved means of tuning an ECD for multimode detection and improved specificity.

30907 Method and apparatus for analyzing the internal chemistry and compositional variations of materials and devices. Kazmerski, L.L. To Dept. of Energy, Washington, DC. USA Patent 4874946/A/. 17 Oct 1989. Filed date 30 Apr 1985. USA Patent Application 6-728,970. Int. Cl. H01J 37/252. 14p.

A method and apparatus is disclosed for obtaining and mapping chemical compositional data for solid devices. It includes a SIMS mass analyzer or similar system capable of being rastered over a surface of the solid to sample the material at a pattern of selected points, as the surface is beingeroded away by sputtering or a similar process. The data for each point sampled in a volume of the solid is digitally processed and indexed by element or molecule type, exact spacial location within the volume, and the concentration levels of the detected element or molecule types. This data can then be recalled and displayed for any desired planar view in the volume.

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Refer also to citation(s) 29963, 29964, 29965, 29967, 30041, 30054, 30444, 30614, 30665, 30691, 30717, 30736, 30857, 30863, 30870, 30882, 30883, 30907, 30972, 31715, 31744, 31977

30908 (CICS–CE02996, pp. 96-98) **The estimation of liquid fuel properties.** Odgers, J. (Laval Univ., Quebec, PQ (Canada)); Kretschmer, D.; Vachon, M. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Depletion of high quality fuel stocks, or cheap energy considerations, often necessitate the introduction of new fuels, some of which will have properties considerably different to those they replace. The work at Laval on alternative fuels indicates that many of the present formulae used to predict fuel properties are inadequate for a wide range of possible fuels. The present objective is to develop correlations such that a maximum number of fuel properties can be predicted from a minimum number of fuel tests. The basic tests selected are density, vicosity, distillation according to ASTM standard, D86. From these measurements, it is hoped to predict

the significant fuel properties which effect combustion. The problem with existing correlations, generally, is that they were determined for application to narrow fuel specifications and they fail when applied outside their limits. To ensure widespread application, new correlations have been tested against a range of hydrocarbon compounds, against simple and complex mixtures of these compounds, and against a range of commercial and research fuels ranging from high octane gasolines to heavy residual fuel oils. It was specified that the accuracy of the new equations should be at least as good as that of the existing correlations when the latter are applied within their limits. 5 refs.

30909 (CONF-891206–12) **Puzzles of electron transfer.** Miller, J.R. Argonne National Lab., IL (USA). [1989]. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From International chemical congress of Pacific Basin Societies (PACIFICHEM '89); Honolulu, HI (USA); 17-22 Dec 1989. Order Number DE90010541. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Major progress has been made to dramatically change our concepts of electron transfer reactions over the last several years by defining the distances, energetics, and even orientation of electron donor and acceptors groups. Despite this progress, several open questions remain. These include the lack of clear understanding of the factors controlling the dependence of the rate on distance. Distance dependence of long distance electron transfer rates is often similar in a variety of experimental situations including rigid glasses, donor and acceptors bound to rigid spacer groups, monolayer assemblies and proteins. But two puzzling cases in which the distance dependence is dramatically weaker have not been understood and interpreted. An even more serious lack of understanding for control of rate by orientation. In some cases strong dependence of rates on solvent polarity have been obtained, but in at least one other case, the rates seem to be independent of polarity. Important energetic quantities such as the free energy change and the solvent reorganization energy are often difficult to obtain and are particularly difficult to predict due to inaccuracies of the dielectric continuum model. This chapter compiles a list of many of these problems, but makes no attempt to suggest the nature of their solutions. 61 refs.

30910 (DOE/ER/13529–2) **Molecular orbital studies of the bonding in heavy element organometallics: Progress report.** Bursten, B.E. Ohio State Univ., Columbus, OH (USA). Dept. of Chemistry. 23 Mar 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13529. Order Number DE90009732. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This progress report contains highlights of research projects in actinide chemistry. Projects covered are bonding in Np, Pu, and transplutonium organometallic compounds, applications of the discrete variational Xα method to actinide chemistry, ab initio calculations on actinide molecules, and experimental comparisons of organoactinide and organotransition metal chemistry. Also included is brief discussions on budgets, funding, invited papers and invited presentations. (JL)

30911 (PB–90-163890/XAB) **Absolute isotopic abundance ratios and atomic weight of a reference sample of nickel.** Gramlich, J.W.; Machlan, L.A.; Barnes, I.L.; Paulsen, P.J. National Inst. of Standards and Technology, Gaithersburg, MD (USA). 1989. 10p. Available from NTIS, PC A04.

Included in Jnl. of Research of the National Institute of Standards and Technology, Vol. 94, No. 6, 347-456(1989).

Absolute values have been obtained for the isotopic abundance ratios of a reference sample of nickel (Standard Reference Material 986), using thermal ionization mass spectrometry. Samples of known isotopic composition, prepared from nearly isotopically pure separated nickel isotopes, were used to calibrate the mass spectrometers.

30912 (PB–90-163908/XAB) **Absolute isotopic composition and atomic weight of terrestrial nickel.** Gramlich, J.W.; Beary, E.S.; Machlan, L.A.; Barnes, I.L. National Inst. of Standards and Technology, Gaithersburg, MD (USA). 1989. 6p. Available from NTIS, PC A04.

Included in Jnl. of Research of the National Institute of Standards and Technology, Vol. 94, No. 6, 357-362(1989).

Twenty-nine samples of high-purity nickel metals, reagent sales and minerals, collected from worldwide sources, have been examined by high-precision isotope ratio mass spectrometry for their nickel isotopic composition. These materials were compared directly with SRM 986, certified isotopic standard for nickel, using identical measurement techniques and the same instrumentation.

30913 Experimental hydration studies of natural and synthetic glasses. Bates, J.K. (Argonne National Lab.., Argonne, IL (US)); Abrajano, T.A.; Ebert, W.L.; Mazer, J.J.; Gerding, T.J. pp. 421 of Materials stability and environmental degradation. Barkatt, A.; Verink, E.D. Jr.; Smith, L.R. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804134–: Symposium on materials stability and environmental degradation, Reno, NV (USA), 5-9 Apr 1988).

The results of a series of hydration experiments on natural glasses (Hawaiian basalt, obsidian) and the nuclear waste glass WV-44 done to examine laboratory methods of accelerating reaction processes are summarized. The glasses were reacted in hydrothermal solution and in saturated vapor water. It was found that different reaction rates and processes were found using the differing conditions, and that laboratory efforts to accelerate and duplicate natural processes must account for the physical processes that occur naturally.

30914 Solubilization of mono- and dichlorophenols by hexadecylpyridinium chloride micelles. Effects of substituent groups. Lee, Byunghwan (Univ. of Oklahoma, Norman (USA)); Christian, S.D.; Tucker, E.E.; Scamehorn, J.F. *Langmuir (USA)*, 6(1): 230-235 (Jan 1990). DOE Contract FG05-87ER13678.

Semiequilibrium dialysis measurements have been made to determine solubilization equilibrium constants and activity coefficients of mono- and dichlorophenols in aqueous solutions of hexadecylpyridinium chloride (CPC) at 25°C. Solubilization equilibrium constants (which relate the concentration of solubilizate in the micelle to the concentration of free organic in the bulk solution) are well correlated by the expression $K = K_0(1 - BX)^2$, where B is an empirical constant, K_0 is the limiting value of the solubilization constant, and X is the mole fraction of the phenol present in the surfactant micelles.

30915 Quantum reactive scattering in three dimensions using hyperspherical (APH) coordinates. IV. Discrete variable representation (DVR) basis functions and the analysis of accurate results for $F+H_2$. Bacic, Z. (Theoretical Division (T-12, MS J569), Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Kress, J.D.; Parker, G.A.; Pack, R.T. *Journal of Chemical Physics (USA)*, 92(4): 2344-2361 (15 Feb 1990).

Accurate 3D coupled channel calculations for total angular momentum $J=0$ for the reaction $F+H_2 \rightarrow HF+H$ using a realistic potential energy surface are analyzed. The reactive scattering is formulated using the hyperspherical (APH) coordinates of Pack and Parker. The adiabatic basis functions are generated quite efficiently using the discrete variable representation method. Reaction probabilities for relative collision energies of up to 17.4 kcal/mol are presented. To aid in the interpretation of the resonances and quantum structure observed in the calculated reaction probabilities, we analyze the phases of the *S* matrix transition elements, Argand diagrams, time delays and eigenlifetimes of the collision lifetime matrix. Collinear (1D) and reduced dimensional 3D bending corrected rotating linear model (BCRLM) calculations are presented and compared with the accurate 3D calculations.

30916 Theoretical studies of fine-structure effects and long-range forces: Potential-energy surfaces and reactivity of $O(^3P)+OH(^2\Pi)$. Graff, M.M. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332-0430 (US)); Wagner, A.F. *Journal of Chemical Physics (USA)*, 92(4): 2423-2439 (15 Feb 1990). DOE Contract W-31109-ENG-38;FG05-88ER13844.

The role of fine structure in reactions without barriers in the potential-energy surface is examined in general, and calculations are carried out for the specific case of $O+OH \rightarrow H+O_2$. The long-range Hamiltonian, including electrostatic (dipole–quadrupole and quadrupole–quadrupole) and spin-orbit interactions, is expressed in

the asymptotic (separated species) basis for the 18 doubly degenerate states correlating to ground-state reactants $O(^3P_{2,1,0})+OH(^2\Pi_{3/2,1/2})$. Adiabatic potential-energy surfaces are determined by diagonalization of the long-range Hamiltonian. The adiabaticity of the reaction has been analyzed using general considerations about nonadiabatic processes and confirmed by direct integration of the coupled equations. The half collision through the coupling region is found to be predominantly adiabatic for the state correlating to reaction. Single-surface reaction cross sections and rate constants have been obtained using the adiabatic capture, infinite-order sudden approximation method. Our results indicate that the reaction is probably fast even at very low temperatures. The effect of reagent rotation on the reaction cross section is also discussed.

30917 Rate constants for the reaction, $H+D_2 \rightarrow HD+D$, over the temperature range, 724–2061 K, by the flash photolysis-shock tube technique. Michael, J.V. (Chemistry Division, Argonne National Laboratory, Argonne, Illinoise 60439 (US)). *Journal of Chemical Physics (USA)*, 92(6): 3394-3402 (15 Mar 1990). DOE Contract W-31109-ENG-38.

Thermal rate constants measured by the flash photolysis-shock tube (FP-ST) technique are reported for the reaction, $H+D_2 \rightarrow HD+D$, over the temperature range, 724–2061 K. H-atom concentration has been monitored by atomic resonance absorption spectroscopy (aras). The results can be represented by the Arrhenius expression: $k_1=(3.95\pm0.35)\times10^{-10}\exp(-5919\pm95\ K/T)$ cm^3 molecule^{-1} s^{-1}, to within ±25% over the temperature range. These results are then combined with lower temperature direct determinations, and a three parameter expression is derived which expresses the rate behavior between 256–2061 K: $k_1=1.69\times10^{-17}T^{1.10}\exp(-3527\ K/T)$ cm^3 molecule^{-1} s^{-1}. The experimental results are then compared to theoretical calculations that utilize *ab initio* potential energy surfaces that are presumably the most exact that have ever been determined. Thus, the theoretical to experimental comparison constitutes a stringent test of the *ab initio* surfaces and the dynamical calculations in which they are used. The conclusion from this comparison is that transition state theory supplies a high quality prediction for the rate behavior, being within ±30% of the experimental data over the entire temperature range.

30918 On the mechanistic dependence of the affinity decay. Hjelmfelt, A. (Department of Chemistry, Stanford University, Stanford, California 94305 (US)); Brauman, J.I.; Ross, J. *Journal of Chemical Physics (USA)*, 92(6): 3569-3578 (15 Mar 1990).

In a series of articles M. Garfinkle has presented an empirical thermodynamic approach to chemical reactions from an initial nonequilibrium state to equilibrium in a closed isothermal system. He claims that (1) (essential points made by M. Garfinkle are numbered for reference later in the text) "a stoichiometric chemical reaction in a closed system traverses a unique *natural path* from reaction initiation to equilibrium. Along such a natural reaction path the time rate of change of the thermodynamic functions can be analytically described independently of phenomenological or mechanistic consideration" [M. Garfinkle, J. Phys. Chem. **93**, 2158 (1989)]. We show these and other claims not to be correct; this approach has validity limited to: reaction mechanisms with essentially only one velocity (mechanisms with one rate-determining step or mechanisms in a quasi-stationary state); reactions occurring at times close to the initial time; and no products present at the initial time. Garfinkle's method of plotting kinetic data, as a function of t^{-1}, suppress information at later times, which shows the inadequacy of his proposed form of the affinity decay, and leads to the erroneous conclusion that a parameter in this form, t_k equal to the most probable time to reach equilibrium, is finite, when in fact it is infinite. The affinity decay rate in general depends on the reaction mechanism, or on the order of the empirical rate equation if determined experimentally.

30919 Absolute state-selected and state-to-state total cross sections for the reaction $Ar^+(^2P_{3/2,1/2})+O_2$. Flesch, G.D. (Ames Laboratory, U. S. Department of Energy, Ames, IA (US)— Department of Chemistry, Iowa State University, Ames, Iowa 50011 (US)); Nourbakhsh, S.; Ng, C.Y. *Journal of Chemical Physics (USA)*, 92(6): 3590-3604 (15 Mar 1990).

Absolute spin–orbit state-selected total cross sections for the reactions, $Ar^+(^2P_{3/2,1/2})+O_2 \rightarrow O^+_2+Ar$ [reaction (1)], O^++O+Ar [reaction (2)], and ArO^++O [reaction (3)], have been measured in the center-of-mass collision energy ($E_{c.m.}$) range of 0.044–133.3 eV. Absolute spin–orbit state transition total cross sections for the $Ar^+(^2P_{3/2,1/2})+O_2$ reaction at $E_{c.m.}$=2.2–177.6 eV have also been examined. The appearance energies for the formation of O^+ ($E_{c.m.}$=2.9±0.2 eV) and ArO^+ (2.2±0.2 eV) are in agreement with the thermochemical thresholds for reactions (2) and (3), respectively. The cross sections for O^+_2, O^+, and ArO^+ depend strongly on $E_{c.m.}$ and the spin–orbit states of Ar^+, suggesting that reactions (1)–(3) are governed predominantly by couplings between electronic potential energy surfaces arising from the interactions of $Ar^+(^2P_{3/2})+O_2$, $Ar^+(^2P_{1/2})+O_2$, and O^+_2+Ar.

30920 Classical and nonclassical forms of the vinyl cation: A coupled cluster study. Liang, C. (Center for Computational Quantum Chemistry, University of Georgia, Athens, Georgia 30602 (US)); Hamilton, T.P.; Schaefer, H.F. III. *Journal of Chemical Physics (USA)*, 92(6): 3653-3658 (15 Mar 1990). DOE Contract FG09-87ER13811.

The energy difference between the classical and nonclassical forms of the vinyl cation is studied using the single and double excitation configuration interaction (CISD) and coupled cluster methods (CCSD and CCSDT-1). The basis sets employed range from double ζ to those including *f* functions on carbon and *d* functions on hydrogen. It is shown that the theoretical energy differences are very sensitive to the inclusion of higher-order polarization functions and the inclusion of triple excitations in the correlated wave functions. The results are compared with other theoretical studies in the literature and with the very recent experimental work of Crofton, Jagod, Rehfuss, and Oka. The most reliable single theoretical treatment involves the CCSDT-1 method with basis set *C*(10*s*5*p*2*d*1*f*/4*s*3*p*2*d*1*f*), *H*(5*s*2*p*/3*s*2*p*), and predicts 3.3 kcal/mol for the classical/nonclassical energy difference. Basis set extension is expected to increase this separation to about 4.0 kcal/mol, still less than the experimental value, >6 kcal/mol.

30921 Chemical probes of metal cluster ionization potentials. Parks, E.K. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Klots, T.D.; Riley, S.J. *Journal of Chemical Physics (USA)*, 92(6): 3813-3826 (15 Mar 1990). DOE Contract W-31109-ENG-38.

A procedure is described for the determination of metal cluster ionization potentials (IPs) using available excimer laser lines that gives error limits substantially smaller than traditional bracketing experiments. It is based on the observation that the adsorption of ammonia on cluster surfaces lowers cluster IPs, and that the IP lowering is linear in the number of adsorbed NH_3 molecules. By determining the minimum number of NH_3 molecules needed for ionization by the various excimer lasers, an approximation to the dependence of IP on coverage can be deduced. Extrapolation of this dependence to zero coverage gives the bare cluster IPs. Results are presented for clusters of iron, cobalt, and nickel having from 4 to 100 atoms. The effect of molecular adsorption on cluster IPs is analyzed theoretically, and the comparison with experimental results used to estimate the effective dipole moment of NH_3 molecules adsorbed on these clusters. Comparison of the bare cluster IPs with the simple spherical drop model suggests that for transition metal clusters the Fermi level can be a significant function of cluster size.

30922 Frequency doubling crystals. Wang, F.; Velsko, S.P. To Dept. of Energy, Washington, DC. USA Patent 4876688/A/. 24 Oct 1989. Filed date 15 Aug 1988. USA Patent Application 7-232,200. Int. Cl. H01S 3/10. 12p.

A systematic approach to the production of frequency conversion crystals is described in which a chiral molecule has attached to it a harmonic generating unit which contributes to the noncentrosymmetry of the molecule. Certain preferred embodiments of such harmonic generating units include carboxylate, guanadyly and imidazolyl units. Certain preferred crystals include L- arginine fluoride,

deuterated L-arginine fluoride, L-arginine chloride monohydrate, L-arginine acetate, dithallium tartrate, ammonium N-acetyl valine, N-acetyl tyrosine and N-acetyl hydroxyproline. Chemical modifications of the chiral molecule, such as deuteration, halogenation and controlled counterion substitution are available to adapt the dispersive properties of a crystal in a particular wavelength region.

4004 Electrochemistry

Refer also to citation(s) 30302, 30308, 30444, 30449, 30450, 30511, 30631, 30634, 31295

30923 (AD-A-217168/4/XAB) **Electrochemical phase diagrams for aqueous redox systems. Final report, 1 August 1986-31 July 1989.** Angus, J.C.; Zappia, M.J.; Yung, R.C. Case Western Reserve Univ., Cleveland, OH (USA). 22 Dec 1989. 29p. Available from NTIS, PC A03/MF A01.

A completely new phase diagram, the electron number diagram, has been developed for aqueous redox systems. The electron number diagram is a transformed potential-pH diagram in which potential is replaced by its thermodynamic conjugate, the number of electrons. The relationship between electron number diagrams and potential-pH diagrams, which provide complementary information, is explained in thermodynamic and geometric terms. Electron number diagrams show any similarities to metallurgical T-x diagrams. Because electron number is a conserved quantity, material balances can be performed on electron number diagrams, and process trajectories can be followed. The mass and electron balance equations are derived, and electron number diagrams are used to illustrate a variety of process trajectories. The diagrams are of particular value in describing the complex phase chemistry involved in aqueous corrosion, hydrometallurgical ore processing, nuclear waste disposal, geochemical processes and some fuel sulfur removal processes. A detailed thermodynamic analysis of complex aqueous redox systems was the basis for algorithms for construction of generalized chemical potential diagrams, potential-pH diagrams and electron number diagrams. Extremely efficient computer programs based on the algorithms were used to construct diagrams for a variety of systems, including the following which include two active redox elements: the aqueous U-C, Cd-Te and Ga-As systems. Extension of these algorithms to systems of arbitrary complexity is also discussed.

30924 Dissociation and product formation in NF_3 radio-frequency glow discharges. Hargis, P.J. Jr. (Sandia National Laboratories, Albuquerque, NM 87185-5800 (US)); Greenberg, K.E. *Journal of Applied Physics (USA)*, 67(6): 2767-2773 (15 Mar 1990). DOE Contract AC04-76DP00789.

Laser Raman spectroscopy was used to measure NF_3 dissociation and N_2 formation in the active volume of 13.56-MHz NF_3 radio-frequency (rf) discharges. Gating the rf discharge suppressed optical emission, allowing NF_3 and N_2 Raman measurements at rf powers where N_2 production was expected to be significant. Greater than 90% dissociation of the NF_3 was observed in a 750 mTorr discharge at rf power densities on the order of 1 W/cm^2 , yet less than 50 mTorr of N_2 was produced. NF was the only other nitrogen containing species detected in the active volume of the discharge.

4005 Photochemistry

Refer also to citation(s) 30833, 30864, 30881

30925 Dynamics of NCS formation from photolysis of RNCS. Northrup, F.J. (Department of Chemistry, Brookhaven National Laboratory, Upton, New York 11973 (US)); Sears, T.J. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 695-697 (20 Oct 1989). DOE Contract AC02-76CH00016. (CONF-8810399--: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Laser induced fluorescence (LIF) was used to probe the internal energy modes of NCS resulting from the 248 nm photolysis of compounds RNCS (R=Me, Et). Accurate spectroscopic constants were determined for the excited vibrational levels for the first time. The NCS fragment was found to be highly excited in all three vibrational modes. Rotational motion was not as highly excited. The dissociation was found preferentially populate the upper spin-orbit component of the ground $^2\Pi$ state.

30926 Photodissociation of 2-bromoethanol and 2-chloroethanol at 193 nm. Hintsa, E.J. (Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, CA (US)—Department of Chemistry, University of California, Berkeley, California 94720 USA); Zhao, X.; Lee, Y.T. *Journal of Chemical Physics (USA)*, 92(4): 2280-2286 (15 Feb 1990). DOE Contract AC03-76SF00098.

2-Bromoethanol and 2-chloroethanol were photodissociated in a molecular beam at 193 nm. Only one primary reaction channel was observed, elimination of the halogen atom, with an average translational energy release of 33 kcal/mol. In the case of 2-bromoethanol, some of the C_2H_4OH partner fragment survived and some underwent secondary dissociation to produce C_2H_4 and OH. The surviving C_2H_4OH contained up to 43 kcal/mol of internal energy, far more than the expected C_2H_4-OH bond energy of ~28 kcal/mol. The initial C–Br recoil occurs with a large exit impact parameter and leaves most of the internal energy in C_2H_4OH rotation, creating rotationally metastable fragments. The angular distributions of the secondary C_2H_4 and OH products were strongly forward–backward peaked with respect to the primary (C_2H_4OH) velocity vector, consistent with the decay of a long-lived complex in which the total angular momentum is perpendicular to the velocity vector and mainly carried away as orbital angular momentum. This effect is analogous to that observed in the decay of similar long-lived complexes in crossed molecular beam experiments.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 30163, 30778, 30910, 31277, 31748, 31749, 31750, 31751, 31752, 31753, 31754, 31755, 31756

30927 (CNIC–00184) **Preparation of a radioimmunoassay kit for 6-keto-prostaglandin $F_{1\alpha}$ using ^{125}I derivative.** Chen Dechun (Suzhou Medical Coll., JS (China)); Wang Zhaoyue; He Yang; Ruan Changgeng. China Nuclear Information Centre, Beijing, BJ (China). Sep 1988. 10p. (In Chinese). (SMC–0022). Order Number DE90626150. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A radioimmunoassay kit for 6-keto-$PGF_{1\alpha}$ was prepared in which ^{125}I-labeled histamine derivative was used. The antiserum was raised by immunizing rabbits with 6-keto-$PGF_{1\alpha}$-BSA conjugate. Its specificity was satisfactory, presenting minor crossreactions (<1%) with different prostaglandins, and its titer was 1:32 000. The ^{125}I-histamine-6-keto-$PGF_{1\alpha}$ was prepared using the chloramine-T procedure, the spcific activity was over 14.8 MBq/μg (400μCi/μg). The minimal detectable limit was 2.2 pg per tube. The recovery rate was 97.2 ≈ 102.3%. The accuracy was 6.62%, and the intra- and inter-assay coefficients of variation were 7.17% and 8.41% respectively. The normal plasma 6-keto-$PGF_{1\alpha}$ value was 22.9±6.3 pg/mL (X ± SD, n=20).

30928 (CNIC–00218) **Process study for removal of radioactivity from lanthanum oxide by HDEHP in HNO_3 system.** Liang Junfu (Qinghua Univ., Beijing, BJ (China). Inst. of Nuclear Energy Technology); Song Chongli; Zhuang Yongneng; Zhang Wei; Zhu Yongjun. China Nuclear Information Centre, Beijing, BJ (China). Jun 1988. 11p. (In Chinese). (TSHUNE–0006). Order Number DE90626129. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The extraction mechanism and separation process of lanthanum and actinium were studied in HDEHP (kerosene)-HNO_2 system. The mathematical model for the extraction of lanthanum and actinium by 50% HDEHP was given from the experimental results. The test tube bench scale and multistage counter-current extraction by centrifugal extractors were carried out for removal α-radioactiity of La_2O_3. The results showed that the recovery of lanthanum is more than 95% at proper condition, the decontamination factor is more than 500 for α-radioactivity and more than 1000 for calcium. The quality of La_2O_3 product satisfies the demands for fluorescent material.

30929 (DOE/ER/60400–4) **Bifunctional chelates of Rh-105 and Au-199 as potential radiotherapeutic agents: [Progress report, June 1, 1989–May 31, 1990].** Troutner, D.E.; Schlemper, E.O. Missouri Univ., Columbia, MO (USA). Dept. of Chemistry. 25 Jan 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60400. Order Number DE90009963. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Since last year we have: continued the synthesis of pentadentate bifunctional chelating agents based on diethylene triamine; studied the chelation Rh-105, Au-198 (as model for Au-199) and Tc-99m with these agents as well as chelation of Pd-109, Cu-67, In-111, and Co-57 with some of them; synthesized a new class of potential bifunctional chelating agents based on phenylene diamine; investigated the behavior of Au-198 as a model for Au-199; begun synthesis of bifunctional chelating agents based on terpyridly and similar ligands; and continued attempts to produce tetradentate bifunctional chelates based on diaminopropane. Each of these will be addressed in this report.

30930 (NAC-AR–86-01, pp. 188-189) **The Pretoria cyclotron facility: Services to industry and other organizations. .** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Physicists of the NPRL and the PCG are jointly responsible for the regulatory aspects concerning the use of radioactive materials at Scientia and for implementing the Department of Health's Regulations Concerning the Control of Electronic Products. Advice was given on the protection of personnel against the hazards of ionizing radiation. The handling, storage and disposal of radioactive wastes for the PCG and other CSIR institutes were undertaken. The supply of short-lived radioisotopes to South African hospitals and other organizations was adversely affected by the problems experienced with the operation of Pretoria-cyclotron and the subsequent overhaul of the machine. A summary of the past year's production of short-lived isotopes for diagnostic and research purposes is presented. 2 tabs.

30931 (RCM–00789) **Characterization of humic acids and humate complexation of Am(III). Contribution to the interlaboratory comparison exercise of the 'COCO-Club' in the CEC project MIRAGE II.** Kim, J.I. (Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie); Buckau, G.; Rhee, D.S.; Li, G.H.; Duschner, H.; Psarros, N. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Dec 1989. 48p. Contract CEC FI 1W-0067-D. Order Number DE90785155. Available from NTIS (US Sales Only), PC A03/MF A01.

The characterization of selected humic acids and the humate complexation behaviour of Am(III) are described. The commercial humic acid (Na salt) from Aldrich Co. is purified to a protonated form and used as a reference material. Humic and fulvic acids extracted and purified from Gorleben groundwaters (FRG) are taken as site specific materials. The characterization of the reference and site specific materials shows that they have very similar chemical properties and represent typical humic acids as known in the literature. By considering the humic acids as ion-exchangers and taking their loading capacity into account, the complexation constant of Am(III) is determined. The thus determined constant is found to be independent of pH and ionic strength. (orig.).

30932 (RCM–01089) **Thermodynamics and speciation: Carbonate complexation of Am(III) and speciation of actinides by pulsed laser spectroscopies. Progress report for the CEC project MIRAGE II.** Kim, J.I.; Klenze, R.; Meinrath, G.; Wimmer, H. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Dec 1989. 51p. Contract CEC FI 1W-0202-D. Order Number DE90785156. Available from NTIS (US Sales Only), PC A04/MF A01.

The report includes the carbonate complexation of Am(III) and speciation of actinides by pulsed laser spectroscopies. Part A describes the carbonate complexation behaviour of Am^{3+} in aqueous solution under 1% CO_2 partial pressure, investigated by solubility and spectroscopic experiments. The average constants determined by the two methods are: log K_{sp} ($Am_2(CO_3)_3$)=-29.7 ± 0.6, log β_1=6.3 ± 0.3 and log β_2 = 9.7 ± 0.6. Part B presents speciation capabilities of three different pulsed laser spectroscopies: laser-induced photoacoustic spectroscopy (LPAS), time-resolved laser-induced fluorescence spectroscopy (TRLFS) and photoacoustic detection of light scattering (PALS). Examples for the speciation of Am(III) and Cm(III) in different aquatic media are presented. (orig.).

30933 (RCM–01089, pp. 1-21) **The carbonate complexation of the Am(III) ion.** Meinrath, G.; Kim, J.I. Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Radiochemie. Dec 1989. Contract CEC FI 1W-0202-D. In *Thermodynamics and speciation: Carbonate complexation of Am(III) and speciation of actinides by pulsed laser spectroscopies. Progress report for the CEC project MIRAGE II.* Order Number DE90785156. Available from NTIS (US Sales Only), PC A04/MF A01.

Am(III) carbonate complexation has been investigated in 0.1 M $NaClO_4$ (or 0.3M $NaClO_4$) under Ar + 1% CO_2 atmosphere at pH=6.0-9.2. Under these conditions the Am^{3+} ion precipitated is found by analysis to be $Am_2(CO_3)_2(S)$. Solubility and spectroscopic experiments are carried out in parallel. The contribution of hydrolysis reactions to total reactions is found to be small at $P_{CO2}=10^{-2}$, but considerable at $P_{CO2}=10^{-3.5}$. The probability of formation of hydroxocarbonate species of Am(III) is discussed. The average constants determined by the two separate experiments are: log K_{sp} ($Am_2(CO_3)_3$)=-29.8 ± 0.6, log β_1=6.3 ± 0.3 and log β_2=9.7 ± 0.6. (orig.).

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 29977, 30185, 30204, 30623, 30627, 30628, 30630, 30633, 30976, 30979

30934 (AD-A–217199/9/XAB) **Multiple ignition, combustion, and quenching of hydrocarbon-fuel sprays. Annual report, 1 July 1981-30 June 1982.** Aggarwal, B.R.; Sirignano, W.A.; Sommer, H.T. Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dec 1982. 40p. Available from NTIS, PC A03/MF A01.

Ignition data has been compiled for combustible gaseous mixtures with hot burning particle sources. High-speed photography, Schileren photography and pyrometry have been employed in the diagnostics. The ignition and non-ignition domains in terms of particle size and mixture ratio have been determined. The design and fabrication of the spray ignition experiment is underway. Finite-difference and asymptotic results have been concluded and the ignition domains have been determined with good agreement (within our limitations of knowledge about chemical kinetics) have been obtained. The preliminary theoretical results about spray ignition indicated that minimum ignition energy and ignition delay should be treated as probabilistic parameters.

30935 (CICS–CE02996, pp. 90-92) **Laminar flame propagation in mixtures of fuel droplets, fuel vapour and air.** Gauthier, J.E.D. (Royal Military College of Canada, Kingston, ON (Canada)); Bardon, M.F. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The study of flame propagation in combustible mixtures of fuel droplets, fuel vapour and air has received only limited attention. Flame propagation into such heterogeneous mixtures is of great interest in many practical applications, from fuel-lean gas turbine operation to the fuel-rich case of cold starting in internal combustion engines. This paper develops a phenomenological model of laminar flame propagation into heterogeneous mixtures. It is applicable to monosized and polysized droplet mixtures and accounts for the effects of changes in pressure, temperature, droplet diameter, overall equivalence ratio, fuel prevaporization and fuel type on the heterogeneous laminar burning velocity. The basis of the model is the hypothesis that flame propagation through heterogeneous mixtures is controlled by the total amount of fuel which becomes

vaporized as droplets pass through the flame front. This includes both the vapour initially present in the fresh mixture, plus the fuel which vaporizes from the droplets passing through the flame front. Explicitly, it is postulated that the heterogeneous burning velocity is that of a homogeneous mixture of equivalence ratio equal to that of the total gas phase which becomes available for chemical reaction inside the flame front. More complete testing of the new model of heterogeneous flame propagation using published experimental data shows that it may be used to calculate the laminar heterogeneous burning velocity with reasonable accuracy. 2 refs., 1 fig.

30936 (CICS–CE02996, pp. 69-71) **The oscillatory behaviour of medium-scale pool fires under varying boundary conditions.** Sobiesiak, A. (Waterloo Univ., Waterloo, ON (Canada)); Weckman, E.J. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The effects on pool fire pulsation characteristics when varying several of the pool boundary conditions were examined for acetone and methanol. These fuels differ in their physical and chemical properties; however the flames resulting from acetone and methanol combustion in 30 cm in diameter pool-fire setup exhibit similar oscillatory behaviour, and have the same characteristic pulsation frequency, 2.7 Hz. In terms of the visual fire structure, this frequency marks formation and evolution of large-scale flame structures. This paper is concerned with the structure of acetone and methanol pool fires and the effects of altering that structure by blocking different proportions of radiation from reaching the liquid fuel surface, reducing the air available to and changing the path of air entrained into the fire by extending the pool rim with varying heights of aluminum screen, and placing a floor around the fire at various heights below the upper rim of the pool. In this study, flow visualization and temperature measurements have been used to reveal the details of the fires behaviour. 3 refs.

30937 (CICS–CE02996, pp. 65-68) **Joint measurements of fluctuating velocity and temperature in a medium-scale pool fire.** Weckman, E.J. (Waterloo Univ., Waterloo, ON (Canada)); Sobiesiak, A. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This paper summarizes the most extensive simultaneous measurements of velocity and temperature taken to date in the continuous flame zone of a medium-scale pool fire. They have confirmed that in the centre of the vapour core, the fuel vapour heats and slowly accelerates due to the presence of high temperature flames and product gases. Near the edges, although there is the continual presence of flame, the axial acceleration of fuel vapour is modified by the radial inflow of entrained air. The large-scale structures, characteristic of these fires, form in the region from middle to top of the continuous flame zone. Here, there is continual combustion on the fire centreline; however, just above this height in the lower regions of the intermittent flame zone, there is significant mixing of combustion gases and slower moving ambient air. Finally, measurements taken in the upper regions of the continuous flame zone clearly mark the passage of the fully developed, large-scale structures which are composed mainly of reaction zones and hot combustion products. All of these results confirm that the continuous flame zone is the source of the large-scale structures which are characteristic of freeburning fires. They have led to new insight into the formation of these structures and a new description of entrainment and mixing at the base of the fire. 4 refs., 6 figs.

30938 (CICS–CE02996, pp. 59-61) **The effect of high intensity turbulence and turbulence scale on burning velocity for 85% stoichiometric methane-air mixtures.** Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Lean burning internal combustion engines are being extensively utilized in order to meet fuel consumption and emission level requirements. One of the characteristics of these leaner mixtures is that they have slower burning velocities than richer mixtures. These slow burning velocities result in the potential for autoignition or knock to occur, causing an engine power output reduction. Past research has shown that a turbulent flow field within the combustion chamber has a marked effect on the flame initiation and propagation and thus, the overall burning velocity. In this study, turbulent combustion research has been performed in a 125 mm cubical combustion cell. Turbulence is produced in the cell by rapidly drawing a perforated plate across the cell. The experimental results show that the burning velocities have a strong dependence on the turbulence root mean square (RMS) intensity and that there is little dependence on the turbulence integral length scale. The greatest burning time decreases are realized when turbulence is introduced to a quiescent mixture, while further and less dramatic decreases are seen as the turbulence RMS intensity is increased. 5 refs., 6 figs.

30939 (CICS–CE02996, pp. 56-58) **The role of cross-section geometry upon flame transmission in tubes.** Kretschmer, D. (Laval Univ., Quebec, PQ (Canada)); Odgers, J.; Guay, D. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

As part of an ongoing program to study the combustion behaviour of simple and complex gas mixtures the role of tube geometry has been investigated with a view to developing shape factors to equivalent circular tube diameters. Methane - air mixtures at ambient conditions were used throughout the present test series. Flame speeds and extinction limits were measured in 24 tubes having six different cross-sectional geometries (circular, square, rectangular, equilateral and non-equilateral triangular, and lozenge). The results were correlated using the equivalent diameter given by Potter's formulae and the equivalent diameter based upon cross sectional area. Both techniques yield similar accuracies when they are correlated against flame limits. The diameters based upon cross sectional areas have been used to correlate the velocities within the tubes and have been shown to be satisfactory. The results have also been used to predict the laminar flame speed of methane/air and the values obtained are in good agreement with published ones. The objective of obtaining a relation between cross sections of different geometries has been achieved to a satisfactory degree. 7 refs., 7 figs., 1 tab.

30940 (CICS–CE02996, pp. 44-47) **Prediction and experiments of bluff-body stabilised combustion: Isothermal flow studies.** Lai, K.Y.M. (National Research Council of Canada, Ottawa, ON (Canada)); D'Souza, M.V.; Campbell, I.G.; Smallwood, G.J. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The basic objective of this project was to verify, by experiment, certain aspects of a computer code called TURCOM, that is under development at the Gas Dynamics lab. of National Research Council (NRC). In its present form, TURCOM models the combustion of gaseous fuels in tubulent flows, and early results have been encouraging, but need verification. An experimental project to validate the relevant physical submodels is in progress, in which bluff body

stabilisation of a propane flame is the problem considered. In this paper, the results of isothermal flow studies only, are presented. In summary, TURCOM computes features of a flow field that are in reasonable quantitative agreement with experiment. For some local phenomena, such as the location of fuel stagnation points, further improvements of the numerical procedure and turbulence model are necessary. With present experimental methods, the measured mass fraction distribution can offer qualitative results only. 7 refs., 5 figs.

30941 (CICS–CE02996, pp. 117-120) **Swirling spark-ignited combustion in a short cylindrical chamber.** Pierik, R.J. (British Columbia Univ., Vancouver, BC (Canada)); Hill, P.G. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

An experimental study has been made of the effects of swirl on combustion duration and heat transfer following spark ignition of a homogeneous methane-air mixture. The objective of this work was to determine burning durations and post-combustion heat transfer rates in a short cylindrical chamber for three types of fluid motion. In the first type there was essentially zero swirl but high turbulence intensity. In the second and third, the turbulence intensity was approximately the same as in the first but two quite different swirl velocity distributions were used - one approximating solid-body rotation, and one more characteristic of a wall jet. With approximately the same rates of turbulent kinetic energy generation at inlet to a cylindrical chamber for three velocity distributions, it has been shown that the burning rate may increase or decrease with swirl, depending on the swirl velocity distribution. When swirl-increases the burning rate,, it appears to affect the early (0 - 10%) burning time much more than the main (10 - 90%) burning time. Increase in turbulence intensity can substantially decrease both early and main burning durations. The spark location yielding the fastest burning depends on swirl velocity distribution. For given inlet turbulence, swirl appears to have little effect on chamber heat transfer. However, changing turbulence intensity can significantly affect wall heat transfer. 5 figs.

30942 (CICS–CE02996, pp. 108-110) **Measurement and prediction of the onset of central recirculation in an annular swirling flow.** Tavasoli, V. (Ottawa Univ., Ottawa, ON (Canada)); Hallett, W.L.H. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Commercial fuel burners and combustors usually employ the central recirculation zone produced by a swirling flow as a means of flame stabilization. This paper describes experiments and a simple theory for the determination of the minimum swirl required to produce recirculation in a sudden expansion flow with a central hub. Experiments were performed in a sudden expansion at the outlet of a swirl generator of the axial-tangential type, whose swirl intensity could be varied by changing the proportions of the tangential and axial air flows. Interchangeable test sections and centre bodies were used to vary the expansion ratio and hub size. Titanium tetrachloride vapour introduced through the centre of the hub was used to generate smoke to visualize the flow, and the swirl was varied to locate the minimum value required to form a stable central recirculation. Results show that central recirculation is generated by the axial pressure gradient produced by an expanding swirling flow, which at sufficiently high swirl intensity stagnates and reverses the axial flow. Addition of a central hub decreases the critical swirl, as the momentum deficiency left by the hub wake reduces the pressure gradient required to reverse the flow. The effect of expansion ratio is not great, except at small ratios; a slight minimum occurs at a ratio of about 2. 2 refs., 3 figs.

30943 (CICS–CE02996, pp. 104-107) **Flammability of methanol/gasoline blends.** Bardon, M.F. (Royal Military College of Canada, Kingston, ON (Canada)); Rao, V.K.; Vaivads, R.; Fisher, D.; Hanna, M.A.; Battista, V. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The volatility characteristics of real fuels are quite complex because they are not pure materials, but instead are mixtures of numerous different components. Unlike a single component fuel, the vapour pressure of a blend depends not only upon its temperature, but also upon how much fuel has already evaporated. For a typical gasoline, the vapour pressure decreases by an order of magnitude as it evaporates at constant temperature. The situation for methanol/hydrocarbon blends is further complicated by the very non-ideal mixtures formed. However, a new technique has recently been developed to model the volatility of non-ideal hydrocarbon alcohol blends. This was used in the present work to evaluate the explosion hazards in fuel tanks and those associated with refuelling. Of the fuels studied, only the Summer M85 blend offers significantly greater hazard than gasoline from the point of view of fuel tank explosibility. The difference lies principally in the higher temperatures at which fuel tank vapours are flammable. At high ambient temperatures, the flammable vapour plumes produced during refuelling are significantly larger for the gasoline than for the other fuels considered. On the other hand, the fuel tank vapours themselves are not flammable under these conditions for any of the fuels studied. At low temperatures, the plume sizes under conditions giving both a flammable plume as well as flammable tank vapours are similar for all fuels. However, this hazardous combination occurs at temperatures some 15°C warmer for M85 than for the other fuels. 4 refs., 6 figs.

30944 (CICS–CE02997) **The Combustion Institute, Canadian Section, 1987 Spring technical meeting.** Combustion Inst. (Canada). Canadian Section. [1990]. 138p. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This meeting was called to discuss theoretical and technical aspects of combution. Topics covered include: fireplaces and other combustors, internal combustion engines, diffusion flames, flame propagation and detonations, and the combustion of liquid and gaseous fuels, the combustion of wood, ignition of Diesel sprays, the mechanisms of combustion, and the design and operation of combustors. Both experimental and computational aspects are covered. Separate abstracts have been prepared for 22 papers.

30945 (CICS–CE02997, pp. 74-79) **Combustion fields in enclosures.** Rotman, D.A. (California Univ., Berkeley, CA (USA)); Oppenheim, A.K. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This paper describes an enclosed combustion field, the combustion process taking place behind a flame front that forms an interface between the burnt and unburnt fuel. The analysis is simplified by adopting the zero Mach number model, which is admissible because of the relatively high temperature. The flame front is endowed with 4 properties, 2 kinematic and 2 dynamic, namely: it is advected by the flow field; it self-advances at the burning speed which is the eigen-value of the system; it acts as a velocity source due to the exothermicity of the combustion; and it acts as a vorticity source due to the baraclinic effect associated with the density gradient across the flame front and the pressure gradient

across its surface. Under such circumstances, assuming that, in the course of combustion, the unburnt medium is compressed isentropically, all the parameters of the thermodynamic component of the problem became dependent solely upon the volume of the burnt medium. The results of a numerical analysis carried out for a flame propagating in a rectangular enclosure are presented with experimental data given for comparison. In the first computation, the vorticity generated by the baroclinic effect has not been included, and the only mechanism whereby a tulip-shaped flame can be formed is the flow reversal imposed by the right-hand corner of the enclosure. In the second computation, which takes into account the baroclinic effect, the tulip shape is formed much earlier. 2 refs., 5 figs.

30946 (CICS–CE02997, pp. 68-70) **Correlating the flammability limits of fuel-diluent mixtures in air.** Wierzba, I.; Cheng, H.; Karim, G.A. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The paper presents a method for the calculation of the lean and rich flammability limits of virtually all the possible combinations of common gaseous fuels, which include hydrogen, methane, carbon monoxide, ethylene and propane with the addition of diluents such as nitrogen, carbon dioxide, helium and argon and with air as oxidizer. The experimental data of the authors and of the open literature show that, for all possible fuel + diluent mixtures, the reciprocal of the lean flammability limit of the fuel + diluent mixture in air is a linear function of the volume concentration of the fuel component in the mixture. The constants a and b of this linear function are discussed. The nature of the rich flammability limit is somewhat different; it is associated with insufficient amounts of oxygen for complete combustion, and, hence, the chemical kinetics of the combustion of the mixture become essential. When a diluent is an inert component, the behaviour of the rich flammability limit is similar to that of the lean flammability limit, with its own constants. However, when carbon dioxide is present in the fuel + diluent mixture, the linear law is no longer observed. Carbon dioxide tends to inhibit the ignition of rich mixtures; this effect is stronger for certain fuels, such as ethylene, and weaker for certain others, such as methane or hydrogen. 1 ref.

30947 (CICS–CE02997, pp. 64-67) **Effect of turbulence intensity and scale on buring velocity of propane/air mixtures.** McDonell, B.J. (Alberta Univ., Edmonton, AB (Canada)); Checkel, M.D. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

While the definitions and measured values of laminar burning velocity are becoming quite uniform in current research, the relationship between turbulent flame propagation and the turbulence which promotes it is still not well defined. The study reported here is an experimental measurement of turbulent flame growth in a sealed combustion test cell with decaying turbulence of variable intensity and scale generated proir to ignition. Turbulence of controllable scale and intensity is generated by passing a plate with variable perforation scale across a 125mm cubical combustion chamber at a controlled speed; ignition at the center of the cell in the wake of the perforated plate allows one to study flame growth/turbulence interactions with decaying turbulence levels, similar to those found in engine cylinders. The turbulance levels are inferred from direct hot wire anemometer measurements; the burning velocity for the early stages of flame growth is inferred from pressure rise rates and confirmed by direct flame photography and by flame ionization detectors. The development of the flame is described; it reaches a very nearly spherical shape by the time a radius of 4cm is reached, despite turbulent wrinkling and distortion. It is confirmed that turbulence intensity has a strong effect on burning velocity. The effect of turbulence scale is less strong, but is significant in different ways for constant-volume conbustion systems. For at least some circumstances, an equal intensity, smaller scale turbulence at the time of ignition is effective in decreasing the overall combustion time. 4 refs., 6 fig.

30948 (CICS–CE02997, pp. 40-55) **Effects of boundary conditions on the propagation of flames in rough tubes.** Gu, L.S.; Lee, J.H.; Knystautas, R. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

There have been a number of studies carried out in recent years on the propagation of flames in obstacle-filled tubes; of particular interest is the classification of the final steady-state propagation into 5 different regimes: self-quenching, weak turbulent deflagration, choking, quasi-detonation, and Chapman-Jouguet detonation. The present paper reports some results on the influence of obstacle configurations on the propagation of a quasi-detonation in atmospheric fuel-air mixtures. The experiments were carried out in 18m long steel tubes of 15cm and 30cm diameters. Circular orifice plates, giving a blockage ratio of 0.5 and 0.43, were used, and their spacing was varied from 0.5 to 2 tube diameters. The fuels used were C_2H_2, C_2H_4, CH_4, C_3H_8 and H_2. The flame speeds were measured with closely-spaced ionization probes located along the whole length of the tube. All the experiments were conducted under the same initial conditions of 1 atm pressure and room temperature. The data obtained on the final steady state flame are discussed. To elucidate the role of heat and momentum losses in the quasi-detonation regime, a one-dimensional model of the flame propagation in a rough pipe was developed. The results from the model show that both heat loss and friction tend to drive the flow towards sonic condition; there is a critical flame speed below which steady quasi-detonation is impossible. In conclusion, the results of the present study seem to indicate a distinct transition from diffusion-to energetic-controlled regimes of flame propagation. 3 refs., 10 figs.

30949 (CICS–CE02997, pp. 128-130) **Observations on the macrostructure of turbulent diffusion flames.** Ding, L. (Queen's Univ., Kingston, ON (Canada)); Becker, H.A. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Observations have been made of gas flames on burners up to 20 mm in diameter and of pan fires of liquid fuels on pans up to 150 mm in diameter. Still photography and video-camera recording were utilized to characterize regularities in the frequency of production of large-scale structures and to study the statistics of fluctuations in visible flame length. Phenomena of lift-off and of the transition from laminar flow to turbulent flow were also observed. The gaseous fuels employed were propane and acetylene and the liquid fuels were methanol, ethanol, benzene and cumene. Propane is an average gaseous fuel; acetylene, on the other hand, gives the extreme in soot production and radiative heat loss. Methanol and ethanol form virtually non-luminous flames, whereas those of benzene are extremely sooty. Results obtained previously be one of the authors on flame oscillation frequency are recalled, and a calculation of the flame temperature is presented. 2 refs.

30950 (CICS–CE02997, pp. 125-127) **On the conduction of ions and electrons in an atmospheric pressure air/propane flame.** MacLatchy, C.S. (Acadia Univ., Wolfville, NS (Canada)). Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring

technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Several mechanisms which control the conduction of ions and electrons in an air/propane flame at atmospheric pressure have been examined. The apparatus is a vertical diode arrangement with the combustion zone acting as one electrode and a flat plate acting as the other. The current to a small detector placed in the center of the flat plate is measured as a function of the biasing voltage over a range of several thousand volts up to the breakdown potential. The chacteristic curve can be divided into five separate regions which are dominated by different electronic and ionic conduction mechanisms. In particular, secondary ionization is observed prior to breakdown at high positive bias while the current is space-charge dominated at high negative bias. When the negative biasing is reduced to 200 V or less, convection of the ions by the combustion gases affects the current. When a positive bias of from a few 10s of volts to 3 kV is applied to the system, the charge generation in the combustion zone has a pronounced effect and may donimate the conduction. Depending on the electrode separation, saturation occurs at about 600 V, extending to the initiation of secondary ioniation at about 3000 V. The saturation current is just the rate of charge generation in the reaction region. The expression of the saturation current and other relevant formulas are recalled. 4 refs., 2 figs.

30951 (JPL-D–6847) **Spray combustion modeling and evaluation: Annual summary report CY 1989.** Back, L.H.; Bellan, J.; Shakkottai, P.; Kwack, E.; Harstad, K. Jet Propulsion Lab., Pasadena, CA (USA). 4 Dec 1989. 137p. Sponsored by U.S. DOE Conservation & Renewable Energy; National Aeronautics and Space Administration. DOE Contract AI01-86CE90237. Order Number DE90010058. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The overall objective of this task is to produce and evaluate an analytical model of multicomponent-fuel spray combustion. It is intended that such a model could ultimately be incorporated into a composite computer program for predicting the performance of furnace and boiler designs fired with arbitrary liquid fuels. The primary intermediate objectives for CY 1989 are to: model the evaporation of individual multicomponent fuel drops, and initiate experiments designed to validate evaporation models developed under this program. 91 refs., 34 figs., 1 tab.

30952 (PB–90-177098/XAB) **On-line spatial and temporal measurement techniques for determination of particle-size distribution. Final report.** Holve, D.J. INSITEC, San Ramon, CA (USA). Sep 1987. 42p. Available from NTIS, PC A03/MF A01.

Researchers developed a new method for non-intrusive spatial and time resolved size distribution measurements which can be used to understand and improve the performance of high particle concentration, high-speed combustion systems, and other powder-processing technologies. The technique is based on a light-scattering method which measures the angular intensity distribution of Fraunhofer-diffracted light from a large ensemble of particles. The method provides spatial and temporal resolution from ensemble particles measurements. Spatial resolution of less than 20-30 mm for particles less than 50 microns in size is feasible. Time resolution of better than five microseconds in conjunction with spatial resolution is also feasible.

30953 **Semiquantitative laser-induced fluorescence flame measurements.** Crosley, D.R. (Molecular Physics Laboratory, SRI International, Menlo Park, California 94025 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 587-592 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

The technique of laser-induced fluorescence (LIF) is a sensitive, selective and nonintrusive means of measuring intermediates important in combustion chemistry. In this article we briefly examine how LIF can be used in a semiquantitative manner to gain insight into aspects of flame chemistry mechanisms. Included are experiments on NH and NS, and extension to simultaneous multiple-species detection.

30954 **Laser-induced fluorescence and dissociation of acetylene in flames.** Raiche, G.A. (Molecular Physcis Laboratory, SRI International, Menlo Park, California 94025 (US)); Crosley, D.R.; Copeland, R.A. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 758-760 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Laser-induced fluorescence and photoinduced dissociation of acetylene is observed in both room temperature cells and low-pressure flames. Acetylene is excited via the $\tilde{A}$–$\tilde{X}$ electronic transition between 210 and 230 nm. The fluorescence exhibits long vibronic progressions due to the different equilibrium geometries; acetylene is trans-planar in the $\tilde{A}$ state and linear in the $\tilde{X}$ state. Intense fluorescence from electronically excited carbon radicals (C^*_2) is also observed upon resonant excitation of C_2H_2 at room and flame temperatures. In addition, a non-resonant laser-induced production of C^*_2 is observed in the flame. The effects of C_2H_2 pressure (i.e., electronic quenching) and laser fluence on fluorescence are examined.

30955 **Simultaneous concentration measurement of CO_2 and H_2 with multiplex CARS in combustion environments.** Singh, J.P. (Diagnostic Instrumentation and Analysis Laboratory, Mississippi State University Mississippi State, Mississippi 39762 (US)); Yueh, F.Y. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 754-757 (20 Oct 1989). DOE Contract AC02-80ET15601. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Multiplex CARS was used to measure CO_2 and H_2 concentrations simultaneously in a combustion environment. CARS spectra of pure CO_2 and various mixtures of CO_2, N_2 and CO_2, N_2, H_2 were recorded using a quartz cell kept in a furnace at various temperatures. The computer code was tested with CO_2 spectra taken at different temperatures. The CO_2 and H_2 concentrations extracted from CARS data were compared with preanalysis data provided by the vendor. The sensitivity of H_2 concentration measurements using the pure rotational S(5) line was compared with those using the S(4) and S(9) lines.

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Refer also to citation(s) 30072, 30109, 30328, 30329, 30525, 30588, 30632, 30647, 30683, 31286, 31329, 31332

30956 (CEA-DAS–643) **The role of the fire dampers in the event of fire in a nuclear facility. Selection criteria for devices.** Savornin, J.; Laborde, J.C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1989. 14p. (CONF-890203–: IAEA international symposium on fire protection and fire fighting at nuclear installations, Vienna (Austria), 27 Feb - 3 mar 1989). Order Number DE90784664. Available from NTIS (US Sales Only), PC A03/MF A01.

In nuclear facilities, where unacceptable quantities of radioactive aerosols could be spread in the event of a fire, the ventilation system must be designed so that an underpressure is maintained under such circumstances. This is the reason why the extracting ventilation of the room in which the fire has broken out has generally to be kept going as long as possible. This prevents smoke and radioactive aerosols from spreading to accessways and adjacent rooms. Consequently, the various devices of the ventilation network need to have high fire resistance. Fire dampers can be applied to exhaust air to delay the heat build-up of a major fire. Specialized qualification testing is required for these dampers. The criteria we have used as a basis for specifying the required qualities of installations are defined. The tests that have been performed, or are now in progress, are described. The results obtained so far are given. Devices and arrangements are suggested.

30957 (CEA-DAS–646) **Means of evaluating the consequences of a fire in ventilation and filtration networks.** Laborde, J.C.; Mulcey, P.; Pourprix, M.; Savornin, J.; Tessier, J. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. d'Analyse de Surete. Oct 1989. 16p. (CONF-890203–: IAEA international symposium on fire protection and fire fighting at nuclear installations, Vienna (Austria), 27 Feb - 3 mar 1989). Order Number DE90784666. Available from NTIS (US Sales Only), PC A03/MF A01.

Accident events involving fire are quite frequent and could have a severe effect on the safety of nuclear facilities. As confinement must be maintained, the ventilation and filtration systems have to be designed to exclude any radioactive release to the environment. To determine and analyse the consequences of a fire on the ventilation network and on its associated air cleaning systems, a research program including the development of calculation codes and experimental studies has been carried out at the Nuclear Studies Centre at Saclay (France). The paper describes the highlights of this research program.

30958 (CONF-900559–14) **Using MAPLE for symbolic computations in robotics.** Kwong, Man Kam (Argonne National Lab., IL (USA)); Wang, Rongdong; Woo, Peng-Yung. Argonne National Lab., IL (USA). [1990]. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990. Order Number DE90010405. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Programs are presented for deriving forward kinematics, Jacobians and dynamic equations of robotic manipulators in symbolic closed forms by using the algebraic manipulation software MAPLE. Examples are given. Efficiency of these computations are discussed. 7 refs.

30959 (CONF-9003102–2) **A PC based computerized maintenance system.** Pruett, D.P.; Walker, G.D.; Imel, G.R. Argonne National Lab., Idaho Falls, ID (USA). Mar 1990. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 12. U.S. TRIGA users conference; Austin, TX (USA); 11-14 Mar 1990. Order Number DE90010068. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The present regulatory climate in the research reactor community has made an easily manageable and auditable maintenance system a necessity. We at NRAD have developed a computer-based system that is easy to implement and use, meets all our regulatory and reporting requirements, and is extremely useful to us in our daily operations. The system, developed at the NRAD reactor facility at Argonne National Laboratory in Idaho Falls, Idaho, uses DBASE-III coupled with C language routines, written for specific purposes. It is a menu-driven system that can be mastered in a short period of time and maintained with only a few hours of computer operation per month. It uses three computer processes: job scheduling, file updating, and report preparation, to produce schedules, work orders, and miscellaneous report forms. The heart of the system is an IBM PC with a 10 MB hard disk, providing adequate data storage capacity for a facility the size of NRAD. The computer is totally dedicated to the maintenance system, thus guarding against inadvertent loss of, or damage to, data files. Computer operator training time is minimized by the menu driven program. Multiple operators can share the computer operation responsibilities, and maintain the system with only 12 to 16 hours of computer operation per month. The system is adaptable to almost any facility, and can be altered and expanded to satisfy changing requirements. 7 figs.

30960 (EGG-M–88360) **Spent fuel shipping cask development status.** Henry, K.H. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Lattin, W.C. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-76ID01570. (CONF-890631–69: International symposium on packaging and transportation of radioactive materials, Washington, DC (USA), 11-16 Jun 1989). Order Number DE90009761. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Nuclear Waste Policy Act of 1982 (NWPA) authorized the US Department of Energy (DOE) to establish a national system for the disposal of spent nuclear fuel and high-level radioactive waste from commercial power generation, and established the Office of Civilian Radioactive Waste Management (OCRWM) within the DOE-Headquarters (DOE-HQ) to carry out these duties. A 1985 presidential decision added the disposal of high-level radioactive waste generated by defense programs to the national disposal system. A primary element of the disposal program is the development and operation of a transportation system to move the waste from its present locations to the facilities that will be included in the waste management system. The primary type of disposal facility to be established is a geologic repository; a Monitored Retrievable Storage (MRS) facility may also be included as an intermediate step in the nuclear waste disposal process. This paper focuses on the progress and status of one facet of the transportation program–the development of a family of shipping casks for transporting spent fuel from nuclear power reactor sites to the repository of MRS facility.

30961 (KCP–613-4232) **The hidden responsibilities of the experimentalist.** Lazarus, L.J. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Mar 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-9006124–4: Society for Experimental Mechanics conference, Albuquerque, NM (USA), 4-6 Jun 1990). Order Number DE90010595. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document considers the responsibility of the experimentalist in the manufacturing and the marketing of "structures" he has developed. Examples are given of how structures that have not been properly designed and tested could place the user and the public at risk. A specific example is the proper number of threads on a screw. 10 refs., 9 figs. (FSD)

30962 (PB–90-862632/XAB) **Storage systems and containers for radioactive materials. February 1971-November 1989 (a Bibliography from the US Patent data base). Report for February 1971-November 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 71p. Available from NTISPC N01/MF N01.

This bibliography contains citations of selected patents concerning container designs for storage, shipping, and handling of radioactive materials. Storage equipment and devices such as sheilding, racks, covers, seals, packing materials, and filling systems for containerized radioactive materials are considered. Radioactive materials considered include nuclear fuels, spent fuels, radioactive wastes, and radioactive research materials. High- and low-level radioactive materials are included. (Contains 139 citations fully indexed and including a title list.)

30963 (SAND–89-1997C) **Approximate minimum-time trajectories for two-link flexible manipulators.** Eisler, G.R.; Segalman, D.J.; Robinett, R.D. Sandia National Labs., Albuquerque, NM (USA). [1989]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005135–3: 1990 American control conference, San Diego, CA (USA), 23-25 May 1990). Order Number DE90009728. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The method of recursive quadratic programming has been used to generate approximate minimum-time tip trajectories for two-link semi-rigid and flexible manipulator movements in the horizontal plane. The manipulator is modeled with an efficient finite-element scheme for an n-link, m-joint system with bending only in the horizontal-plane. Constraints on the trajectory include boundary conditions on position and energy for a rest-to-rest maneuver, straight-line tracking between boundary positions, and motor torque limits. Trajectory comparisons utilize a change in the link stiffness to compare a semi-rigid configuration to a flexible one. The level of bending flexibility necessary to excite significant modal behavior is demonstrated. Applied torques for minimum-time maneuvers are shown to be very similar between configurations and retain much of the qualitative character of rigid-body slewing motion. 13 refs., 8 figs., 1 tab.

30964 (SAND–90-0085) **Haptic perception with an articulated, sensate robot hand.** Stansfield, S.A. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 36p. Sponsored by U.S.

DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010195. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we present a series of haptic exploratory procedures, or EPs, implemented for a multi-fingered, articulated, sensate robot hand. These EPs are designed to extract specific tactile and kinesthetic information form an object via their purposive invocation by an intelligent robotic system. Taken together, they form and active robotic touch perception system to be used both in extracting information about the environment for internal representation and in acquiring grasps for manipulation. The haptic system presented utilizes and integrated robotic system consisting of PUMA 560 robot arm, a JPL/Stanford robot hand, with joint torque sensing in the fingers, a wrist force/torque sensor, and 256 element, spatially-resolved fingertip tactile array. We describe the EPs implemented for this system and provide experimental results which illustrate how they function and how the information which they extract may be used. In addition to the sensate hand and arm, the robot also contains structured-lighting vision and a Prolog-based reasoning system capable of grasp generation and object categorization. We present a set of simple tasks which show how both grasping and recognition may be enhanced by the addition of active touch perception. 34 refs., 23 figs.

30965 (SAND–90-1009C) **Performance problems of dimensional measurement systems.** Gonzales, J.F. Sandia National Labs., Albuquerque, NM (USA). 19 Mar 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005164–1: IMOG measurement technology subgroup meeting, Largo, FL (USA), May 1990). Order Number DE90009975. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purposes of this one day meeting were to identify and to consolidate the issues associated with the performance of dimensional measurement systems as indicated by the results of the DOD Quality Assurance Council, the National Science Foundation, the Rich Walker GIDEP Alert, the B89 Standards Committee's work, IMOG Measurement Technology Subgroup discussions, NIST, and the CAM-I DITS (Dimensional Inspection Technologies Standards) Project. The expected results were a clearer definition and understanding of the problems, establishment of objectives for problem resolution, an approach to resolve the problems, and the identification of potential funding requirements and sources. 10 figs.

30966 **Diverted assembly for radioactive material.** Andrews, K.M.; Starenchak, R.W. To United States Dept. of Energy. USA Patent 4886401/A/. 12 Dec 1989. Filed date 11 Apr 1988. USA Patent Application 7-179,922. Int. Cl. B65G 51/24. vp.

This patent describes a diverter assembly for diverting a pneumatically conveyed holder for radioactive material between a central conveying tube and one of a plurality of conveying tubes radially offset from the central conveying tube. It comprises: an air-tight container having a hollow interior, a first aperture about which the central tube is connected, and a respective plurality of second apertures about which respective offset tubes are connected; a diverter tube in the container having a first end located immediately adjacent the first aperture and a second end offset from the first end a distance equal to the radial offset of the conveying tubes from the central tube; a first mounting means in the container for mounting the diverter tube for rotation about a longitudinal axis of the first end such that the second end is selectively brought into alignment with respective the second apertures; a rotary seal means for sealing the first end of the diverter tube from the interior of the container during and after rotation of the diverter tube; a spring biased seal means for sealing the second end of the diverter tube from the interior of the container during and after rotation of the diverter tube to a selected second aperture; an indexing means for rotatable indexing the second end of the diverter tube; and a drive means for selectively driving the indexing means.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 29961, 30185, 30371, 30416, 30727, 30869, 30938, 30939, 30942, 30951, 30977, 30979, 31959

30967 (CICS–CE02996, pp. 84-85) **Heat transfer mechanisms associated with a boiling liquid expanding vapor explosion.** Steward, F.R. (New Brunswick Univ., Fredericton, NB (Canada)); Venart, J.E.S.; McDevitt, C.A.; Sumathipala, U.K.M. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Certain hydrocarbon fuels such as propane and butane are shipped and stored under pressure in the liquid state. When such a vessel containing the liquid with a vapor space is heated it can undergo a devastating type of explosion known as Boiling Liquid Expanding Vapor Explosion, BLEVE. The mechanism of heat transfer associated with this type of explosion has been investigated within our laboratory by a combination of physical and mathematical models. One physical model consists of a pressure vessel containing Freon-11 as the working fluid. The vessel is cylindrical in shape with plexiglass ends so that the various phenomena occurring within the chamber can be viewed during an experiment. The container can be electrically heated through the walls at a controlled heat flux. The vessel is equipped with a pressure relief valve which is programmed to open at the desired pressure or time depending on the experiment. Numerous temperatures, pressures, and heat fluxes have been measured as a function of time for various tests. The mass of the Freon-11 within the vessel and the thrust of the jet through the pressure relief valve have also been continuously recorded. A further series of tests have been conducted by rupturing small tanks containing propane or Freon-12 under a wide range of temperatures and fraction of tanks filled with liquid in various positions. High speed photography was used to determine how the tank failed. With this data it has been possible to prescribe under what conditions a BLEVE may be expected to occur. 3 figs.

30968 (CICS–CE02996, pp. 125-127) **Improved zone method for industrial furnace modelling.** Kocaefe, Y.S. (Quebec Univ., Chicoutimi, PQ (Canada)); Charette, A.; Bui, R.T. Combustion Inst. (Canada). Canadian Section. [1988]. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). In *The Combustion Institute, Canadian Section, 1988 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

It is well established that radiation is the major mode of heat transfer in most combustion chambers. The zone method which treats radiation as a global phenomenon is a powerful method for the radiative heat transfer analysis. This study focuses on improving this method with respect to its application in industrial furnace modelling. The zone method is based on the division of the system into finite surface and volume zones with uniform properties, and the solution of energy balances written for these zones. The interactive nature of radiation is taken care of by the interchange factors which have to be calculated between every possible pair of zones. Treatment of non-gray radiation by the sum-of-gray-gases approach simplifies the computational effort significantly without any sacrifice in accuracy. The determination of direct interchange factors requires multiple intergrations with respect to geometry which limits the application of the method to a great extent. This problem had been overcome by the use of Monte Carlo technique which relaxed this limitation and offered significant flexibility. With the latter technique, the total interchange factors can be calculated directly avoiding the two-step approach in the original formulation. In addition, the limitation on the zone size is no longer valid. This technique was adopted in the present study. Calculations were carried out from a 1.2 x 3.75 x 10.5 m furnace containing a real gas. The bottom surface is the heat sink, and the fuel is natural gas. Computation times were compared for the two techniques. Saving range from 5%, for gray gas applications, to a vast reduction in the number of iterations (from 41 to 4) for real gas cases. 3 refs., 1 fig.

30969 (DOE/ER/13930–T1) **Particle deposition in granular media: Progress report summary, June 1, 1988–Present.** Tien,

Chi. Syracuse Univ., NY (USA). Dept. of Chemical Engineering and Materials Science. [1990]. 51p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13930. Order Number DE90010810. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The purpose of the studies "Particle Deposition in Granular Media" is aimed at obtaining a quantitative understanding of the process of deposition of aerosol particles from gas streams flowing through granular media and the formulation of a basic framework for describing the process. During the period June 1, 1988 to date, a number of investigations have been carried out including: Transient Behavior of Granular Filtration, Modification of Porous Media Model for Aerosol Deposition Studies, Stochastic Simulation of Particle Deposition, and Analysis of Filter Candle Performance. Results of the studies are discussed separately.

30970 (LA-UR–90-1374) **Forced convection film boiling drag and heat transfer of a wedge.** Chappidi, P.R. (Los Alamos National Lab., NM (USA)); Pasamehmetoglu, K.O.; Gunnerson, F.S. Los Alamos National Lab., NM (USA). [1990]. 10p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900619–4: 5. AIAA/ASME thermal physics and heat transfer conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90010611. Available from NTIS, PC A03/MF A01 - OSTI.

Laminar forced convection film boiling flow on a wedge is analyzed considering the streamwise pressure gradient imposed on the flow and the streamwise buoyancy force (important because of the large density difference between the vapor and liquid) acting on the vapor film. A two-phase boundary layer model is proposed, and the local similarity concept is applied to obtain an approximate solution of the governing equations. Parametric trends in this analysis show that, for a water-steam system at atmospheric pressure considered within this study, the density difference between the vapor and liquid is large enough. As a result, both the streamwise pressure gradient and the buoyancy force exert strong influence on the vapor flow dynamics. Wall skin friction results display a strong dependency on the streamwise buoyancy force driving the vapor film and the external pressure gradient. Previously observed "skin friction bucket" type phenomena with increased heating of the wedge are possible when the buoyancy force is small or negligible. Adverse streamwise buoyancy force action on the vapor film, which is the case on the lower surface of a horizontally aligned wedge, may cause vapor flow separation. In contrast to wall skin friction dependency, the wall heat-transfer parameter shows a secondary dependence on the streamwise pressure gradient and the buoyancy force. 16 refs., 9 figs., 3 tabs.

30971 (SAND–87-0645) **The effect of stratification on gravitational coagulation and settling of aerosols.** Mondy, L.A. (Sandia National Labs., Albuquerque, NM (USA)); Griffiths, S.K. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010153. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The differential equations describing the gravitational collision and coalescence of aerosol particles have been solved numerically, using an explicit two-step marching procedure, for the simple case of a single-component aerosol settling in a quiescent environment. The initial particle size distribution is arbitrary and is allowed to change in time due to coagulation and loss due to precipitation. These equations are solved at discrete heights, with the aerosol assumed to be homogeneous (well-mixed) in each height interval. The term describing precipitation allows for the transfer of mass from one height to the next lower and, so on, to the ground. This allows one-dimensional spatial stratification to develop when larger particles, that continue to grow due to coagulation, settle faster than the smaller particles. Numerical studies show that stratification in particle size and concentration can be significant in some cases. Stratification rates increase as the initial concentration of particles increases and as the range of initial particle sizes increases. Comparison of results from a well-mixed model and a height dependent model shows that significant differences in the predicted fallout rates can occur. 22 refs., 5 figs.

30972 Numerical analysis of binary solid-liquid phase change with buoyancy and surface tension driven convection. Incropera, F.P. (Purdue Univ., Lafayette, IN (USA). Heat Transfer Lab.); Engel, A.H.H.; Bennon, W.D. *Numerical Heat Transfer (USA)*, 16(4): 407-428 (1989).

The effects of thermo/diffusocapillary convection on the solidification of aqueous NH_4Cl in a rectangular cavity have been simulated numerically using a newly developed continuum model. Diffusocapillary convection is negligible relative to thermocapillary convection, and for a 20 × 20 mm cavity in a one-gravity environment, thermocapillary effects are most pronounced during the early stages of solidification, when flow conditions are characterized by three major cells. One cell, driven by solutal buoyancy forces, extends from the mush region to the melt and separates top and bottom melt region cells driven primarily by surface tension and buoyancy forces, respectively. With increasing time, however, the top cell strengthens and eventually envelops the entire melt. In terms of the strength of the flow, the liquidus front morphology, and the amount of solid formed, final conditions differ only slightly from those predicted for pure thermal/solutal convection.

4205 Materials Testing

Refer also to citation(s) 30284, 30383, 30406, 30603, 30604, 30653, 30655, 30656, 30659, 30661, 30664, 30722, 30767, 30842, 30859

30973 (CONF-8810352–, pp. 285-298) **Hard surfaces nondestructive testing techniques: Comparative evaluations.** Rastaldo, A. (FIAT CIEI, Turin (Italy)); Torrida, G.; Frigerio, G. ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. In *Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan 19-20 Oct 1988.* Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

ENEA (Italian Commission for Alternative Energy Sources) and FIAT CIEI (Italy) conducted a research study to verify and compare various nondestructive testing techniques applied to hard surfaces obtained by automatic welding using Colmonoy 4 and 5 and Everit stainless steels. The control methods examined were: eddy current, liquid penetrant, ultrasonic and radiography. It was determined that eddy current testing is best applied prior to machine finishing; liquid penetrant testing is applicable only to surface defects; ultrasonic techniques are applicable to volumetric examinations; radiography is applicable only to simple geometry, thin surfaces.

30974 (ORNL/ATD–35) **Dynamic response of a lightweight gun barrel during a firing-pressure transient.** McGrath, S.V.; Phillips, L.P. Jr. Oak Ridge National Lab., TN (USA). Apr 1990. 59p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90010893. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents the results of a nonlinear, dynamic structural analysis of a gun barrel design during a firing-pressure transient. The final design was defined by an iterative design/analysis process in which the effects of design modifications were compared with established design criteria. The ADINA finite element code was used to analyze the titanium/carbon composite gun barrel assembly for a maximum transient pressure of 29,000 psi. The gun barrel weighs 42 lb; however, a significant potential exists for weight savings in future gun barrel designs. 2 refs., 41 figs.

30975 Subpicosecond reflective electro-optic sampling of electron-hole vertical transport in surface-space-charge fields. Min, L. (Department of Chemistry and Institute for Optics, University of Rochester, Rochester, New York 14627 (US)); Miller, R.J.D. *Applied Physics Letters (USA)*, 56(6): 524-526 (5 Feb 1990). DOE Contract FG02-85ER13455.

A new method of electro-optic sampling field transients, using above-band-gap optical probes in reflection, is analyzed theoretically and experimentally demonstrated to be within a factor of 2 as sensitive as electro-optic sampling in transmission. The technique is ideally suited to the study of interfaces due to the surface selective nature of the evanescent field probe. Studies of the dynamics

of photogenerated electron-hole pair separation in surface-space-charge fields at GaAs(100)/oxide interfaces show that the hole carrier transit time is faster than 500 fs. Using longitudinal electro-optic sampling beam geometries, this technique has an intrinsic resolution of 50 fs.

4210 Combustion Systems

Refer also to citation(s) 30023, 30024, 30025, 30090, 30315, 30518, 30940, 30944

30976 (CICS–CE02996) **The Combustion Institute, Canadian Section, 1988 Spring technical meeting.** Combustion Inst. (Canada). Canadian Section. [1988]. 129p. (CONF-8806469–: The Combustion Institute Canadian Section spring technical meeting, Halifax (Canada), 1-3 Jun 1988; CE–02996). Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

This meeting was called to provide a forum for the discussion of both practical and theoretical aspects of combustion. Included are presentations on combustion physics and modelling with a special focus on liquid or gaseous fuels and on flame propagation. Coverage of practical aspects includes discussion of combustion in furnaces, in spark ignition engines, fuel additives, fuel explosions, and fuel residues and emmissions. Separate abstracts have been prepared for 21 papers.

30977 (CICS–CE02997, pp. 15-17) **Comparison of the various methods for analysing the radiative heat transfer in furnaces.** Kocaefe, Y.S. (Quebec Univ., Chicoutimi, PQ (Canada)); Charette, A.; Munger, M. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Radiation plays a major role in the overall heat transfer within combustion chambers. This requires an accurate determination of the radiative heat transfer from the flame to the heat absorption surfaces for a reliable design and modelling of these devices. This paper gives a brief review of the methods available and presents some results for their comparison. The five methods are the zone method, the Monte Carlo method, the discrete transfer method, the imaginary planes method and the flux method. The latter approximates the equation of heat transfer by a differential equation; due to the localization of radiation, this method is less reliable compared to the others. The first four methods have been applied to a 1.5 x 4.5 x 12 m furnace containing a gas with an absorption coefficient of 0.2 m -1 and a given temperature distribution; the bottom surface is the heat sink. The conclusions are the following: the imaginary planes and dis-crete transfer method, which requires an iterative procedure for the heat flux calculation, is at a slight disadvantage. If the interchange factors are available or are to be calculated only once, the low computational time favors the zone method. 5 refs., 2 figs., 1 table.

30978 (CICS–CE02997, pp. 7-11) **Fireplace and chimney design for energy efficient housing.** Preto, F. (Energy Research Lab., CANMET, Ottawa, ON (Canada)); Hayden, A.C.S. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705403–: The Combustion Institute Canadian Section spring technical meeting, Vancouver (Canada), 28-29 May 1987; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

Modern housing technology incorporates increased insulation and airtightness levels, which has raised concerns about the efficiency and safety of fireplaces and chimneys. The objectives of fireplace and chimney design are two-fold: to provide an adequate draft under a wide range of operating conditions, and to maximize thermal efficiency. The traditional approach to chimney design has been to select the flue size based on the chimney height and the frontal opening of the fireplace according to rules of thumb which, in old houses, have proven to be satisfactory. In the present computational study, the following procedure was adopted: the maximum burning rate for a given size fireplace was estimated based on a maximum air velocity of 0.3 m/s at the fireplace opening and an excess air level of 1800%, Upon selecting a flue diameter and insulation level, the mean flue gas temperature was calculated, the draft was calculated, the pressure drop was calculated, and these steps were repeated until the draft equalled the pressure drop. The conclusions are that the flue size should be reduced from the current size of 8.12% of the frontal opening to about 6% of the frontal opening; and that the flue should be insulated to aid in producing a strong draft. Also, since fireplaces must not depressurize the house and must be resistant to malfunction, and since they must consume little or no indoor air, they should be isolated from the house by the use of tight-fitting glass doors and an outside air supply. More research is needed to establish the outside air vent specifications. 4 refs., 2 figs., 2 tabs.

30979 (CONF-8910289–6) **An experimental study of combustion and heat transfer in porous radiant burners.** Sathe, S.B.; Kulkarni, M.R.; Peck, R.E.; Tong, T.W. Arizona State Univ., Tempe, AZ (USA). Dept. of Mechanical and Aerospace Engineering. [1989]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13697. From Western States Section meeting of the Combustion Institute; Livermore, CA (USA); 23-24 Oct 1989. Order Number DE90010032. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have studied experimentally the stability and heat transfer characteristics of lean premixed, methane-air flames embedded in a porous layer. The work is directly relevant to understanding the performance and operating behavior of porous radiant burners (PRB). Flame speed and radiant output data were obtained for different stoichiometries and flame locations in porous ceramic foam. The results indicate that stable combustion at elevated flame speeds can be maintained in two different spatial domains: one spanning the upstream half of the porous are also found to increase as the flame is shifted toward the middle of the porous layer. A one-dimensional laminar premixed flame model incorporating a radiatively participating inert porous medium was used to describe the test conditions. Calculations using a one-step reaction confirmed the observation of two stable flame regions. The predicted flame speeds and radiant output agree favorably with the experimental trends. 20 refs., 4 figs.

4220 Mining and Underground Engineering

Refer also to citation(s) 31670

4230 Marine Engineering

Refer also to citation(s) 30661

30980 (GKSS–89/E/30) **Subsea work with robots in hyperbaric environments.** Aust, E.R.; Bohm, K.H.; Domann, H.; Schultheiss, G.F. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 7p. (CONF-890549–: 21. offshore technology conference and exhibition (OTC-21), Houston, TX (USA), 1-4 May 1989). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

The work presently reported is part of a comprehensive underwater technology R and D-program at GKSS. A special subject in this program is the development of advanced robots applicable for hyperbaric dry and wet environments in order to mechanize subsea work. As a first step in this program modified industrial robots are used for working processes in a pressurized chamber, which simulates the hyperbaric dry ambient conditions of an underwater habitat up to 110 bar. The performed tests have shown reliable functions of the modified robots and of the auxiliary equipment and indicated the feasibility to mechanize offshore-relevant working procedures like welding and jet cutting of steel plates under the severe conditions of a pressurized inertgas atmosphere. This development opens a new field of robot application for subsea work

in order to assist and later on to replace divers and thereby to reduce human subsea intervention. (orig.).

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 30747, 30748, 30754, 30802, 30807, 30906, 31111, 31287, 31303, 31304, 31306, 31307, 31309, 31311, 31312, 31313, 31315, 31316, 31709, 31920, 31991

30981 (AD-A-216632/0/XAB) **Laser-diode side-pumped Nd:$YAlO_3$ laser at 1.08 and 1.34 micrometers.** Hanson, F. Naval Ocean Systems Center, San Diego, CA (USA). 1 Jul 1989. 4p. Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 14, No. 13, 674-676(1 Jul 1989).

We report efficient pulsed operation of a b-axis Neodymium: Yttrium Aluminum Oxide laser rod at 1.08 and 1.34 micrometers side-pumped by laser-diode arrays. Optical slope efficiencies of 27% and 20% were obtained at these wavelengths. Polarized absorption spectra were taken for Nd:$YAlO_3$ along the three principal axes in the region of the pump bands from 780 to 830 nm.

30982 (AD-A-217142/9/XAB) **Femtosecond time-domain measurements of group-velocity dispersion in AlGaAs diode lasers.** Allen, J. Massachusetts Inst. of Tech., Cambridge, MA (USA). May 1989. 3p. Available from NTIS, PC A01/MF A01.

Pub. in Electronics Letters (11th), Vol. 25, No. 10, 640-641(May 1989).

Femtosecond optical pulses are used to determine the round-trip propagation delay in AlGaAs diode lasers. By using pulses at different wavelengths, we have determined the dispersion in group index to be minus 2.9 per micrometer in these devices.

30983 (AD-A-217163/5/XAB) **Homoclinic and chaotic transitions in the rf (radio frequency) superconducting quantum interference device (SQUID). Presentation paper.** Jacobs, E.W.; Bulsara, A.R.; Schieve, W.C. Naval Ocean Systems Center, San Diego, CA (USA). Jun 1989. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Chemical Propulsion Information Agency Publication No. CPIA-PUB-517, Vol. 1, 309-310(Jun 1089).

We consider a simple model of the flux in an rf superconducting quantum-interference device (SQUID) subjected to an external periodic magnetic field. The dynamic equation describing the flux response of the SQUID is solved analytically in the absence of damping and external driving terms. These terms are then introduced as perturbations, and the Melnikov function for the system is constructed. The transition from periodic to chaotic behavior is studied through a calculation of the Lyapunov exponents for the systems, and the dimension of the strange attracting set is calculated.

30984 (AD-A-217171/8/XAB) **Femtosecond passively mode-locked Ti:Al_2O_3 laser with a nonlinear external cavity.** Allen, J. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Electrical Engineering and Computer Science. 15 Oct 1989. 4p. Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 14, No. 20, 1125-1127(15 Oct 1989).

Nonlinear-optical feedback that uses an external coupled cavity is a powerful technique for enhancing the performance of mode-locked lasers. Ultrashort pulses are generated in a Titanium:Aluminum Oxide laser by using a coupled nonlinear external cavity. The external cavity uses self-phase modulation in an optical fiber to achieve passive mode locking without the need for synchronous pumping or acousto-optic modulation. A stable train of chirped 1.4-psec pulses is generated. After dispersive compensation, pulses as short as 200 fsec are obtained.

30985 (AD-A-217400/1/XAB) **Quality inspection test, demonstration and evaluation report for high-reliability laser polarizers. Revision.** Litton Systems, Inc., Orlando, FL (USA). Laser Systems Div. 24 Feb 1988. 173p. Available from NTIS, PC A08/MF A01.

This report presents the results of the evaluation of 50 High Reliability Laser Polarizers to fulfill part of the requirements for Phase III of Contract No. DAAK20-85-C-0137.

30986 (AD-A-217562/8/XAB) **Highly uniform GaAs/AlGaAs grin-sch sqw diode lasers grown by organometallic vapor phase epitaxy.** Wang, C.A.; Choi, H.K.; Connors, M.K. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. Nov 1989. 5p. (JA-6309). Available from NTIS, PC A01/MF A01.

Pub. in IEEE Photonics Technology Letters, Vol. 1, No. 11, 351-353(Nov 1989).

A high degree of uniformity in the characterization of high performance GRIN-SCH diode laser has been achieved by using a specially designed reactor for growth by organometallic vapor phase epitaxy. Broad-area test devices were fabricated with a single 10 nm thick AlGaAs quantum-well active layer. For the characteristics measured during pulsed operation of 175-192 lasers with a cavity length of 500 micrometers, distributed over a 16 sq cm. wafer, the mean values and standard deviations are, respectively; threshold current density 288 and 11.3 A/Sq cm; differential quantum efficiently 83.0 and 2.5 percent; and emission wavelength 804.9 and 0.6 nm. For lasers from ten wafers grown under the same nominal conditions, the wavelengths range from 803.5 to 807.4 nm.

30987 (AD-A-217563/6/XAB) **Gain-switched pulsed operation of microchip lasers.** Zayhowski, J.J.; Ochoa, J.; Mooradian, A. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1 Dec 1989. 5p. (JA-6347). Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 14, No. 23, 1318-1320(1 Dec 1989).

Microchip lasers have produced single-frequency, gain-switched pulses with a FWHM as short as 760 psec for Nd:YAG(Nd(x)Y(3-x)Al(5)O(12)) and 80 psec for LiNdP(4)O(12)(LNP).

30988 (AD-A-217584/2/XAB) **Plasma dynamics.** Massachusetts Inst. of Tech., Cambridge, MA (USA). Research Lab. of Electronics. Jan 1984. 10p. Available from NTIS, PC A02/MF A01.

Pub. in RLE Progress Reports, No. 126, 95-102(Jan 1984).

Relativistic electron beam research at M.I.T. focuses on the generation of intense coherent electromagnetic radiation in the centimeter, millimeter and submillimeter wavelength ranges. The primary radiation mechanism which is being studied at the present time is the free electron laser instability which is excited when an electron beam passes through a spatially periodic, transverse magnetic field (wiggler field). This instability is characterized by axial electron bunching and has emission wavelengths associated with the Doppler upshifted wiggler periodicity.

30989 (AD-A-217587/5/XAB) **Binary-optics miniature Talbot cavities for laser-beam addition.** Leger, J.R.; Griswold, M.P. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1 Jan 1990. 4p. (JA-6329). Available from NTIS, PC A01/MF A01.

Pub. in Applied Physics Letters, No. 56, 4-6(1 Jan 1990).

A miniature external cavity has been fabricated from a single 4.5 mm substrate for coherent beam addition of a linear AlGaAs laser array. Binary-optics elements are fabricated on the front surface laser beam collimation and onto the back surface for lateral mode selection. Near-diffraction-limited performance has been observed with up to 80% of the far-field power contained in the central lobe.

30990 (AD-A-217590/9/XAB) **Raman gain suppression with multimode lasers.** Heinrichs, R.M.; Winkler, I.C. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1 Jan 1990. 6p. (JA-6272). Available from NTIS, PC A02/MF A01.

Pub. in The American Physical Society, Physical Review A, Vol. 41, No. 1, 395-399(1 Jan 1990).

We have found the gain of a Raman amplifier to be almost completely suppressed when the amplifier is pumped by a multilongitudinal mode laser and seeded with an initially uncorrelated Stokes beam that is nearly as intense as the pump. This effect is predicted by a plane-wave model of Raman amplification that accounts for multimode pump and Stokes fields. Our experiments have also demonstrated that the beam quality of the pump is maintained to the extent that the amplification is suppressed.

30991 (AD-A-217592/5/XAB) **Lasers without inversion: interference of dressed lifetime-broadened states.** Imamoglu, A.; Harris, S.E. Stanford Univ., CA (USA). Edward L. Ginzton Lab. 15 Dec 1989. 3p. Available from NTIS, PC A01/MF A01.

Availability: Pub. in Optics Letters, Vol. 14, No. 24, 1344-1346(15 Dec 1989). No copies furnished by DTIC/NTIS.

We describe the use of a coupling electromagnetic field to provide a general method of producing inversion-free laser systems. The interference between dressed states produces a zero in absorption while allowing gains of the order of that of the uncoupled system.

30992 (AD-A-217598/2/XAB) **High-efficiency flashlamp-pumped titanium: Sapphire laser.** Lacovara, P.; Esterowitz, L.; Allen, R. Unified Industries, Inc., Springfield, VA (USA). 1989. 6p. Available from NTIS, PC A02/MF A01.

A flashlamp-pumped titanium: sapphire laser has been operated with efficiencies approaching 1% using a fluorescent converter. Performance of specific fluorescent converters is described, and ways to further increase the efficiency at the titanium: sapphire laser are discussed.

30993 (AD-A-217599/0/XAB) **Flash-pumped titanium laser.** Esterowitz, L.; Allen, R.; Lacovara, P. Unified Industries, Inc., Springfield, VA (USA). 1989. 4p. Available from NTIS, PC A01/MF A01.

A flashlamp pumped titanium sapphire laser has been operated with efficiencies approaching 1% using a fluorescent converter. Performance of specific fluorescent converters is described, and ways to further increase the efficiency at the titanium sapphire laser are discussed.

30994 (AD-A-217600/6/XAB) **Growth, spectroscopy, and lasing of titanium-doped sapphire.** Esterowitz, L.; Lacovara, P. Unified Industries, Inc., Springfield, VA (USA). 1989. 20p. Available from NTIS, PC A03/MF A01.

The announcement of efficient, broadly tunable laser action in titanium-doped sapphire has inspired considerable work. Experiments at NRL, and elsewhere have demonstrated successful lasing using both flashlamp and laser pumping. Crystal quality, however, is in great need of improvement, since loss within the material is as much as an order of magnitude greater than would be expected for high-quality sapphire. In this paper we discuss some of the problems associated with the growth of this material and point out their effect on laser performance. We also show some areas where the spectroscopy of this material is not well understood, and propose some explanations for these spectroscopic features.

30995 (CONF-891119–126) **The effect of magnetic field on the critical current density of bulk superconducting wires.** Lanagan, M.T.; Balachandran, U.; Youngdahl, C.A.; Dusek, J.T.; Picciolo, J.J.; Poeppel, R.B. Argonne National Lab., IL (USA). Nov 1989. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90010458. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Bulk YBa_2Cu_3O7-x (YBCO) wires and tubes were fabricated by a conventional extrusion technique and sintered above 900°C. The critical current density (Jc) was measured as a function of applied magnetic field at 77 K, and was found to decrease significantly at fields below 100 G. A manifestation of the magnetic field dependence of Jc is the correlation between critical current density and specimen geometry. In addition, when a concentric magnetic field was generated by passing a current though a copper wire, the external field from the wire could constructively or destructively interfere with the magnetic field produced by current in the YBCO tube. Jc was found to increase by 10% when the current in the YBCO tube was opposite to the current in the copper wire. The large change in electrical properties with magnetic field has been attributed to weak link behavior at the grain boundaries. Batch to batch differences in the field dependence of Jc imply the possibility of reducing the dependence by processing modifications. 10 refs., 3 figs.

30996 (CONF-891208–32) **High-temperature superconductors for space power transmission lines.** Hull, J.R. (Argonne National Lab., IL (USA)); Myers, I.T. Argonne National Lab., IL (USA). 4 Aug 1989. 24p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From Winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (USA); 10-15 Dec 1989. Order Number DE90009725. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Analysis of high-temperature superconductors (HTS) for space power transmission lines shows that they have the potential to provide low-weight alternatives to conventional power distribution systems, especially for line lengths greater than 100 m. The use of directional radiators, combined with the natural vacuum of space, offers the possibility of reducing or eliminating the heat flux from the environment that dominates loss in terrestrial systems. This leads to scaling laws that favor flat conductor geometries. From a total launch weight viewpoint, HTS transmission lines appear superior, even with presently attainable values of current density. 21 refs., 4 figs.

30997 (CONF-900133–2) **Synthesis of ceramic superconductors under low oxygen pressure.** Balachandran, U.; Poeppel, R.B.; Emerson, J.E.; Lanagan, M.T.; Youngdahl, C.A.; Johnson, S.A. Argonne National Lab., IL (USA). Dec 1989. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From International conference on superconductivity; Bangalore (India); 10-14 Jan 1990. Order Number DE90010415. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have developed a process for synthesizing orthorhombic $YBa_2Cu_3O_x$ ("123") superconducting powders, which involves calcination of the precursor powder under reduced total oxygen pressure. Because a single calcination at 800°C for 4 h in flowing oxygen with a pressure of 2 mm Hg results in essentially phase-pure material, total calcination times have been drastically reduced. At liquid nitrogen temperature, sintered pellets made from this powder have critical current densities of ~1000 A/cm^2 in zero applied magnetic field. 7 refs., 2 figs.

30998 (CONF-8910120–10) **Improved processing of ceramic superconductors.** Poeppel, R.B. (Argonne National Lab., IL (USA)); Balachandran, U.; Emerson, J.E.; Johnson, S.A.; Lanagan, M.T.; Youngdahl, C.A.; Eror, N.G. Argonne National Lab., IL (USA). Oct 1989. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 1. international ceramic science and technology congress; Anaheim, CA (USA); 31 Oct - 3 nov 1989. Order Number DE90009721. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Vacuum calcination of precursor powder under controlled total oxygen pressure has been investigated for synthesizing $YBa_2Cu_3O_x$ (YBCO) superconductor. The reaction temperature, ~800°C, is ~100°C lower than that used in ambient-pressure calcination. Since a single calcination results in essentially phase-pure material, total calcination times have been drastically reduced. The vacuum-calcined powder has finer particles and consequently greater sinterability than powders made by conventional methods. Samples made from this powder have critical current densities of ~1000 A/cm^2 at 77 K in zero applied external magnetic field. 14 refs., 4 figs.

30999 (DOE/ER/14012–1) **MIT [Massachusetts Institute of Technology] short-wavelength laser project: Progress report, May 15, 1989–January 1, 1990.** Hagelstein, P.; Basu, S.; Muendel, M.; Kaushik, S.; Braud, J.P.; Tauber, D.; Wyss, R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Research Lab. of Electronics. 1990. 99p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14012. Order Number DE90008975. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

We review the status of the short wavelength laser project at MIT. At this point we are on schedule relative to our initial proposal: the power amplifier is under construction at LLNL, the vacuum chamber has been designed, and development of the alignment system is underway. We report progress on the design of whisper gallery mirror EUV laser cavities, and have proposed a new scheme for frequency mixing in the EUV. We anticipate our first laser plasma experiment late spring or early summer of 1990.

31000 (LA-UR–90-1125) **Development of free-electron lasers for xuv projection lithography.** Newnam, B.E. Los Alamos National Lab., NM (USA). [1990]. 19p. Sponsored by U.S. DOE

Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900140–23: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90010566. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Future rf-linac-driven FELs, operating in the range from 4 nm to 100 nm, could be excellent exposure tools for extending the resolution limit of projection optical lithography to $\leq$0.1 μm and with adequate total depth of focus (1 to 2 μm). When operated at a moderate duty rate of $\geq$1%, XUV FELs should be able to supply sufficient average power to support high-volume chip production. Recent developments of the electron beam, magnetic undulator, and resonator mirrors are described which raise our expectation that FEL operation below 100 nm is almost ready for demonstration. Included as a supplement is a review of initial design studies of the reflecting XUV projection optics, fabrication of reflection masks, characterization of photoresists, and the first experimental demonstrations of the capability of projection lithography with 14-nm radiation to produce lines and spaces as small as 0.05 μm. 88 refs., 10 figs.

31001 (ORNL/TM–11530) **Laser range camera modeling.** Storjohann, K. Oak Ridge National Lab., TN (USA). Apr 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90008220. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes an imaging model that was derived for use with a laser range camera (LRC) developed by the Advanced Intelligent Machines Division of Odetics. However, this model could be applied to any comparable imaging system. Both the derivation of the model and the determination of the LRC's intrinsic parameters are explained. For the purpose of evaluating the LRC's imaging model into a standard camera's (SC) pinhole model is derived. By virtue of this transformation, the evaluation of the LRC's external orientation can be found by applying any SC calibration technique. 7 refs., 7 figs.

31002 (PB–90-177023/XAB) **Growth of fluoride laser crystals with electrochemical monitoring and control of composition and purity. Phase 1.** White, S.H. EIC Labs., Inc., Norwood, MA (USA). Aug 1987. 62p. Available from NTIS, PC A04/MF A01.

The performance of a tunable solid-state laser is dependent upon the purity of the host crystal and the dopant materials. The Phase I program examines the feasibility of electroanalytical methods to detect oxidic species and transition-metal redox processes in a host-fluoride flux and to determine the ability of constant potential electrolysis for salt purification. The results of these studies have shown that oxide ions can be detected electrochemically at concentrations below approximately 0.01 molal in the host laser flux. Low concentrations of oxide species can be detected easily because of the presence of surface processes in the electrochemical oxidation pathway, whereas higher concentrations will employ the diffusion controlled processes. Oxidation states of transition-metal ions, typified by nickel, can be controlled by potential electrolysis and detected and measured by dynamic electroanalytical methods such as cyclic voltammetry and chronopotentiometry.

31003 (SAND–88-2174) **Characterization and development report for the SA2859: A silicon controlled rectifier.** McCarty, C.E. Sandia National Labs., Albuquerque, NM (USA). 12 Feb 1990. 118p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010196. Available from NTIS, PC A06/MF A01 - OSTI.

This report documents the design, development, and testing of the SA2859, a diffused planar epitaxial silicon controlled rectifier manufactured by Texas Instruments (TI). 18 figs., 35 tabs.

31004 (SERI/TP–210-3723) **Conference on the science and technology of thin-film superconductors: Book of abstracts.** Solar Energy Research Inst., Golden, CO (USA). [1990]. 196p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. (CONF-900432–Absts.: Science and technology of thin-film superconductors conference, Golden, CO (USA), 30 Apr - 4 may 1990). Order Number DE90000326. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This document contains abstracts from papers presented at the Conference on Science and Technology of Thin-Film Superconductors. Among the topics covered are: "Conditions for the In Situ Formation of Yoco Films," "High T_cSuperconducting Layered Structures and Superlattices," "Characterization and Applications of Superconducting Thin Films," and "Fabrication and Growth of Superconducting Thin Films." (FSD)

31005 (UCRL–99297) **Materials for high average power lasers.** Marion, J.E.; Pertica, A.J. Lawrence Livermore National Lab., CA (USA). Jan 1989. 17p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890145–27: SPIE conference on optics, electro-optics and laser applications in science and engineering: OE/LASE '89, Los Angeles, CA (USA), 15-20 Jan 1989). Order Number DE90010744. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Unique materials properties requirements for solid state high average power (HAP) lasers dictate a materials development research program. A review of the desirable laser, optical and thermo-mechanical properties for HAP lasers precedes an assessment of the development status for crystalline and glass hosts optimized for HAP lasers. 24 refs., 7 figs., 1 tab.

31006 High index of refraction films for dielectric mirrors prepared by metal-organic chemical vapor deposition. Brusasco, R.M. (California Univ., Livermore, CA (USA). Lawrence Livermore National Lab.). pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

A wide variety of metal oxides with high index of refraction can be prepared by metal-organic chemical vapor deposition. The authors present some recent optical and laser damage results on oxide films prepared by MOCVD which could be used in a multilayer structure for highly reflecting (HR) dielectric mirror applications. The method of prepartation affects both optical properties and laser damage threshold.

31007 Overview of recent advances in excimer laser technology at Los Alamos. Bigio, I.J. (Los Alamos National Lab., Laser Science and Applications Group, MS-E543, Los Alamos, NM (US)); Sze, R.C.; Taylor, A.J.; Gibson, R.F. pp. 276 of Excimer lasers and applications. Basting, D. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8809124–: Excimer lasers and applications, Hamburg (Germany, F.R.), 21-23 Sep 1988).

From among the areas of excimer laser development at Los Alamos two are selected for discussion: ultra-high brightness excimer laser systems and discharge-pumped XeF(C[ar]A) lasers operating in the blue-green portion of the spectrum. Two different high brightness systems are described. One is based on small-aperture KrF amplifiers, while the other is based on a large-aperture XeCl amplifier. The XeF(C[ar]A) laser is tunable from 435 to 525 nm, and may one day become a viable alternative to pulsed dye lasers for many applications.

31008 New concepts for high current self-sustained diffuse discharge closing switches. Hunter, S.R. (Oak Ridge National Lab., TN (USA). Health and Safety Research Div.); Christo phorou, L.G.; Carter, J.G.; Datskos, P.G. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ USA) (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The authors describe switching concepts that potentially can increase the efficiency and stability of high current diffuse discharges when used in repetitive fast closing switch applications. The primary advantage of diffuse discharges over spark gap closing switches is that a diffuse discharge has a much faster recovery time ($<10^{-4}$ s) compared to an arc discharge ($>10^{-3}$ s), enabling the switch to be operated at high repetition rates. The major disadvantage of

diffuse discharges are the high sustaining voltage across the discharge and the resultant high switch impedance (several ohms) compared with spark gaps ($<1\omega$). The discharge sustaining voltage may be reduced (i.e. switch efficiency increased) by using the energy deposited in the gas in a power loaded switch to modify the electron gain or loss processes of the gaseous constituents of the discharge. Specifically, this can be accomplished by using gases where the electron attachment coefficient of an electronegative gas component decreases with increasing gas temperature (i.e. increasing degree of vibrational excitation). The authors also explored a new diffuse glow discharge operating scheme.

31009 Dielectric modification of repetition rate tested polycarbonate perfluorcarbon capacitors: The G.H. Mauldin memorial report. . Mauldin, G.H. (Sandia National Labs., Albuquerque, NM (USA)); Schreiner, E.T.; Harris, J.O.; Thompson, M.C.; Somoano, R.B.; Yen, S.P.S. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

It appears the operational life of a perfluorocarbon impregnated capacitor is a strong function of the crystalline-amorphous character of the polycarbonate (PC) dielectric material. X-ray diffraction studies and thermomechanical analysis (TMA) of the material at the Jet Propulsion Laboratory, Pasadena, California, have shown new information. Gas studies of the impregnate solution have yielded new answers also. The authors also discuss the dynamics of both the equivalent series resistance (ESR) and the equivalent dynamic capacitance of an in situ device as observed during testing at a test facility.

31010 Raman scattering studies of the oxygen deficient phase of the Y-Ba-Cu-O superconductor. Slakey, F. (Dept. of Physics and Materials Research Lab., Univ. of Illinois Urbana-Champaign Urbana II (US)); Klein, M.V.; Bukowski, E.D.; Rice, J.P.; Ginsberg, D.M. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Investigations of single crystal $YBa_2Cu_3O_7$ revealed striking properties: antiresonance behavior and renormalization of the vibrational modes, A_{1g} and B_{1g} symmetry components of an electronic continuum, and redistribution of this continuum for temperatures below T_c. Raman studies of the $Bi_2Sr_2CaCu_2O_{8+\Delta}$ compound revealed similar properties suggesting that at least some of these features may in fact be intrinsic to the high temperature superconductors. The authors current investigations focus on the oxygen deficient, T_c = 60K, and insulating phases of the Y-Ba-Cu-O system and further detail the intrinsic quality of these features. The decreased oxygen concentration in these phases respectively serves to weaken and eliminate the electronic continuum.

31011 Complex microwave susceptibility of natural SQUID structures. Yau, W.F. (Univ. of California at Berkeley, Berkeley, CA (US)); Portis, A.M.; Weber, E.R.; Wang, Z.Z.; Ong, N.P. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Dispersive behavior associated with the sharp periodic absorption lines that have been attributed to fluxion nucleation within Josephson junctions has been observed in single crystals of $YBa_2Cu_3O_{7-\delta}$. Both the absorption and dispersion signals are interpreted with an rf SQUID model that associates the absorption signal with hysteresis and the dispersive signal with constant flux. The observed broadening above a threshold in microwave power of the absorption and dispersion into bands is given a simple interpretation with the rf SQUID model. The observed constancy of the absorption amplitude with increasing rf power may also be interpreted simply on the basis of hysteresis.

31012 Raman spectra and normal mode assignments of superconducting $YBa_2Cu_4O_8$ single crystals. Krantz, M.C. (IBM Almaden Research Center, San Jose, CA (US)); Rosen, H.J. MacFarlane, R.M.; Asmar, N.G.; Morris, D.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Single crystals of $YBa_2Cu_4O_8$ high temperature superconductors with well characterized structural, magnetic, and transport properties have been studied by Raman microprobe spectroscopy in various polarization geometries. The unique orthorhombic structure, spacegroup Ammm, with double linear Cu-O chains along the a-axis gives rise to two additional modes of A_g symmetry that are not present in the single chain $YBa_2Cu_3O_7$(1:2:3) structure. Comparison of the observed spectra with $YBa_2Cu_3O_7$ shows four modes at nearly identical positions and with comparable strengths to the known 1:2:3 A_g modes as expected from the similar structure. Two additional peaks observed at 250 cm^{-1} in the $YBa_2Cu_4O_8$ spectrum have no corresponding modes in the spectrum of fully oxygenated I:2:3. This suggests their assignment to A_g modes associated with Cu-O bending and stretching motion in the double chains as predicted by factor group analysis.

31013 Superconductivity from valence fluctuations with finite U. Brandow, B.H. (Theoretical Div., Los Alamos National Lab., Los Alamos, NM (US)). pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The finite-U pairing mechanism of Newns is found to be opposed by a magnetic tendency arising from Gutzwiller renormalization of the hybridization. This competition restricts superconductivity to the parameter regime (cgd) (gte) U, and this also reproduces the parabolic rise and fall of T_c in $La_{2-x}Sr_xCuO_4$ with increasing x. Re-analysis of the photoemission data for CuO reveals that indeed (cgd) (gte) U for this compound, contrary to previous work.

31014 Magnetic hysteresis and ac reponse of $YBa_2Cu_3O_z$ films. Kerchner, H.R. (Solid State Div., Oak Ridge National Lab, P.O. Box 2008, Oak Ridge, TN (US)); Feenstra, R.; Christen, D.K.; Sekula, S.T.; Thomson, J.O.; Thomson, J.R.; Kim, Y.C. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports the dc magnetic hysteresis and audio-frequency ac susceptibility studied for $YBa_2Cu_3O_x$ films of different epitaxial orientations on $SiTiO_3$. The apparent critical current density deduced from the ac susceptibility is in reasonable agreement with that deduced from the slowly-swept-field dc result, but no with the quasistatic dc hysteresis. Both the ac-voltage waveform from the mutual inductance bridge and the slow decay of magnetic moment in a static applied field show magnetic flux creep.

31015 Two-laser approach to X-ray lasers. Tighe, W. (Princeton University Plasma Physics Laboratory, Princeton, New Jersey 08543 (US)); Meixler, L.; Nam, C.H.; Suckewer, S. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 57-62 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Progress in X-ray laser studies at Princeton University's Plasma Physics Laboratory (PPPL) is proceeding along many fronts. Along

with finding applications for the recombination soft X-ray laser operating at 18.2 nm, there are intense efforts to generate shorter wavelength output and higher energy output. There are multi-laser approaches involved in attaining both of these goals but here we will primarily discuss the effort to develop shorter wavelength X-ray lasing by using two pump lasers. The motivation for this approach will be presented along with a description of the status of the experiment and initial spectra obtained from preliminary solid-target interaction experiments.

31016 Reduction of tetravalent chromium induced optical loss in Nd:Cr:GSGG. Pertica, A.J. (Lawrence Livermore National Laboratory, Livermore, CA 94550 (US)); Marion, J.E.; Stokowski, S.E. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 103-105 (20 Oct 1989). DOE Contract W-7405-ENG-48. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We report on methods for eliminating of optical absorption in neodymium, chromium doped gadolinium scandium gallium garnet (Nd;Cr:GSGG) due to tetravalent chromium at the laser wavelength. These methods include doping of the crystal melt with specific additive as well as post growth heat treatments.

31017 Modeling the energy deposition in the aurora KrF laser amplifier chain. Comly, J.C. (University of California, Los Alamos National Laboratory, Los Alamos, NM 87545 (US)); Czuchlewski, S.J.; Greene, D.P.; Hanson, D.E.; Krohn, B.J.; McCown, A.W. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 119-124 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Monte carlo calculations model the energy depositions by highly energetic electron beams into the cavities of the four KrF laser amplifiers in the Aurora chain. Deposited energy density distributions are presented and studied as functions of e-beam energy and gas pressure. Results are useful for analyzing small signal gain (SSG) measurements and optimizing deposition in future experiments.

31018 Amplified spontaneous emission and pulse train amplification in a KrF amplifier. Ackerhalt, J.R. (Los Alamos National Laboratory, T-12, MS-J569, Los Alamos, NM 87545 (US)); Hanson, D.E.; Adams, R.G.; Raymond, T.D.; Reiser, C.; Rice, J.K.; Michie, R.B. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 112-118 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We present modeling studies of pulse-train amplification experiments conducted at Sandia National Laboratory in Albuquerque (SNLA) with an e-beam pumped KrF laser amplifier. The laser geometry is such that the dominant amplified spontaneous emission (ASE) growth is along the propagation axis. Our numerical studies include the propagation of on axis co- and counter-propagating fields for both the pulse train and ASE simultaneously. The time-dependent gain, absorption, formation and quenching rates are obtained from a state-of-the-art kinetics code developed at Los Alamos National Laboratory (LANL).

31019 X-ray generation from subpicosecond superintense laser–atom interaction. Lee, P.H.Y. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Casperson, D.E.; Schappert, G.T.; Olson, G. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(3): 272-275 (Mar 1990). DOE Contract W-7405-ENG-36.

We review results from an experimental investigation to examine the characteristics of x-ray generation from subpicosecond UV laser irradiation of collisionless gas targets under conditions such that the optical field strength is larger than an atomic unit. The purpose of the experiment was to test the conjecture that multiphoton-induced inner-shell excitation occurs at large laser irradiance. We found no evidence to support the validity of the conjecture at $I \sim 3 \times 10^{17}$ W/cm^2. We did, however, detect delayed x rays, which were generated for unexpectedly long times following laser irradiation of the target. We present numerical simulations describing the processes that give rise to this signal.

31020 Nonlinear Gaussian expansions of stochastic processes: Non-Gaussian effects in coherent anti-stokes Raman spectroscopy. Lau, A.M.F. (Combustion Research Facility, Sandia National Laboratories, Livermore, CA 94550 (US)); Farrow, R.L. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 262-264 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We propose a new approach to the analysis of stochastic processes (such as fluctuating laser fields) with non-Gaussian statistics: the expansion of stochastic processes in terms of first and higher power of Gaussian components, which are used like a basis set. This approach is applied to treat the non-Gaussian correlation effects observed in coherent anti-Stokes Raman scattering experiments using frequency-doubled pump-laser fields. Our results give much better agreement with experimental data than previous theories.

31021 Influence of a.c. Stark effect on stimulated hyper-Raman profiles in sodium vapor. Moore, M.A. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6378 (US)); Garrett, W.R.; Payne, M.G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 268-270 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

When pumping near the two-photon $3d$ resonance in pure sodium vapor and observing the backward hyper-Raman emission to the $3p$ substates, an asymmetry in ratios of $3p_{1/2}$, $3p_{3/2}$ associated emissions was observed dependent upon the direction of the initial laser detuning from the resonance. It has been determined that this asymmetry can be attributed to the a.c. Stark effect induced by the hyper-Raman emission itself.

31022 Suppression of two-photon resonantly enhanced nonlinear processes in extended media. Garrett, W.R. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tenneessee 37831-6378 (US)); Moore, M.A.; Payne, M.G.; Wunderlich, R.K. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 273-275 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

On the basis of combined experimental and theoretical studies of nonlinear processes associated with two-photon excitations near $3d$ and $4d$ states in Na, we show how resonantly enhanced stimulated hyper-Raman emission, parametric four-wave mixing processes and total resonant two-photon absorption can become severely suppressed through the actions of internally generated fields on the total atomic response in extended media.

31023 Experimental studies of self-suppression of vacuum ultraviolet generation in Xe. Judish, J.P. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tenneessee 37831-6378 (US)); Allman, S.L.; Garrett, W.R.; Payne, M.G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 276-278 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Vacuum ultraviolet light in the range 116 nm to 117 nm was produced by using a two-photon resonant four-wave mixing scheme in Xe. The buildup of coherent cancellation of the two-photon resonant transition employed in the generation of the vacuum ultraviolet, with resulting limitations imposed on the achievable vacuum ultraviolet intensity was investigated. Under certain predicted conditions, increases in the intensity of one of the pumping beams, ≈1500 nn infrared, or tuning this beam towards resonance with the $5p^5 7s(3/2)_1$ level of Xe led, not to increases, but decreases in the vacuum ultraviolet generated.

31024 New coherent cancellation effect involving four-photon excitation and the related ionization. Payne, M.G. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tenneessee 37831-6378 (US)); Garrett, W.R.; Judish, J.P.; McCann, M.P. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 279-281 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We describe here an effect which occurs when a first laser is tuned near a dipole allowed three-photon resonance and a second laser is used to complete a dipole allowed four-photon resonance between the ground state $|0\rangle$ and an excited state $|2\rangle$. In this process three photons are absorbed from the first laser and one photon from the second; so that if the $|0\rangle$ to $|2\rangle$ transition is two-photon allowed the transition is also pumped resonantly by the third harmonic field due to the first laser and the second laser field. When the second laser is strong enough to cause strong absorption of the third harmonic light, and the phase mismatch, Δk is large and dominated by the nearby resonance, a destructive interference occurs between the pumping of the $|0\rangle$ to $|2\rangle$ transition by two- and four-photon processes.

31025 Effect of the coherent cancellation of the two-photon resonance on the generation of vacuum ultraviolet light by two-photon resonantly enhanced four-wave mixing. Payne, M.G. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6378 (US)); Garrett, W.R.; Judish, J.P.; Wunderlich, R. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 282-284 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Many of the most impressive demonstrations of the efficient generation of vacuum ultraviolet (VUV) light have made use of two-photon resonantly enhanced four-wave mixing to generate light at $\omega_{VUV} = 2\omega_{L1} \pm \omega_{L2}$. The two-photon resonance state is coupled to the ground state both by two photons from the first laser, or by a photon from the second laser and one from the generated VUV beam. We show here that these two coherent pathways destructively interfere once the second laser is made sufficiently intense, thereby leading to an important limiting effect on the achievable conversion efficiency.

31026 Diode laser-initiated, two-color resonance ionization mass spectrometry of lanthanum. Shaw, R.W. (Oak Ridge National Laboratory, Oak Ridge, TN 37831 (US)); Young, J.P.; Smith, D.H. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 288-290 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

A GaAlAs semiconductor diode laser tuned to 753.93 nm was utilized to excite the first step of three-photon resonance ionization processes of lanthanum. A practical resonance ionization mass spectrometric (RIMS) instrument based solely on diode laser optical excitation is envisioned.

31027 Two-photon resonant, stimulated processes in krypton and xenon. Miller, J.C. (Chemical Physics Section, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6125 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 294-296 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Both on-axis and conical emissions have been observed following two-photon pumping of the 5p states of krypton and the 6p′, 7p, 8p, and 4f states of xenon. In the former case, coherent emissions from the 5p states to the 5s are observed and in the latter case, many p → s, d → p, and f → d cascade emissions are observed. By analogy to the well-studied alkali and alkaline earth examples, the emissions are discussed in terms of amplified spontaneous emission (ASE), stimulated hyper-Raman scattering, and parametric four-wave mixing. The physical processes responsible for the conical emission and for intensity anomalies in the xenon p → s emissions are not understood at present. Interference effects due to coherent cancellation between competing excitation pathways may be occurring.

31028 Surface-plasmons enhanced nonequilibrium electronic and lattice heating in thin silver films. Tsang, T. (Purdue University, W. Lafayette, Indiana 47907 (US)); Smith, D.D. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 345-347 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We report the first observation of nonequilibrium heating of electronic and lattice in a thin silver film enhanced due to the excitation of single metal-boundary surface plasmons at the metal-air interface. The surface-plasmon-enhanced heating is probed on a picosecond time scale by thermally-induced changes in the ultraviolet reflectivity of the thin film. The heating enhancement due to plasmon decay is more than 2 orders of magnitude as compared to heating by a directly incident laser beam.

31029 Saturation of inter-subband transitions in p-type semiconductor quantum wells. Chang Yiachung (University of Illinois at Urbana-Champaign, Urbana, IL 61801 (US)); James, R.B. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 318-323 (20 Oct 1989). Contract ONR-N00014-81-K-430. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Saturation behavior of inter-subband optical transition in p-type semiconductor quantum wells is examined theoretically. Carrier-phonon scatterings are taken into account within the deformation-potential approximation. Deviation of the hole distribution from thermal equilibrium due to optical pumping is calculated by solving coupled rate equations. Pump-and-probe absorption spectra are also studied and possible applications for light-by-light modulation are discussed.

31030 Two-photon induced chemical reactions in liquids. Chen, C.H. (Chemical Physics Section, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6378 (US)); McCann, M.P. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 354-356 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

A two-photon absorption process has been used for the first time to produce significant quantities of reaction products between halogen containing organic compounds and silver containing inorganic compounds in the condensed phase. The mechanisms for these chemical reactions were also studied and confirmed by two-photon absorption spectra and optoaccoustic methods.

31031 Excimer laser-controlled photochemical deposition of thin films and artificially structured materials. Lowndes, D.H. (Solid State Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6056 (US)); Eres, D.; Geohegan, D.B.; Tischler, J.Z.; Mashburn, D.N.; Pennycook, S.J. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 382-390 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Excimer laser photolysis is attractive for low-temperature film deposition because high resolution in film thickness can be combined with useful deposition rates, at temperatures that are too low for pyrolysis. Examples of ArF (193 nm) laser photolysis of hydride molecules to deposit amorphous superlattices are presented. Transmission electron microscopy demonstrate that thin (5–25 nm) layers with reproducible thickness and sharp boundaries can be deposited under photonic control. Results of low-temperature growth of crystalline and amorphous Ge films by pyrolysis and photolysis of digermane also are described. Experimental limitations encountered using these, and other, parent molecules are discussed, and general principles are outlined for efficient low-temperature photoepitaxial film growth using excimer lasers.

31032 Performmance of Ho:YAG s a function of temperature. Barnes, N.P.; Getterny, D.J. *Applied Optics (USA),* 29(3): 404-409 (20 Jan 1990).

The performance of two multiply doped Ho:YAG lasers has been characterized as a function of the laser rod temperature. From the experimental results, the dependence of the slope efficiency and threshold on temperature has been extracted. Threshold can be correlated with the occupation of the lower laser level. Implications on the optimum operating temperature are discussed.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 31554, 31791, 31940

4301 Design, Development, and Operation

Refer also to citation(s) 30180, 31074, 31077, 31102, 31241, 31752, 31755, 31756

31033 (AD-A-217337/5/XAB) **ARDEC (Armament Research, Development, and Engineering Center) electric gun in-house test program-fiscal year 1988. Annual report, October 1987-September 1988.** Dunham, C.; Coradeschi, T.; Chang, D.I.; Van Camp, K.; Colombo, G. Army Armament Research and Development Center, Dover, NJ (USA). Fire Support Armament Center. Jan 1990. 53p. (ARFSD-TR-89021). Available from NTIS, PC A04/MF A01.

This report summarizes the experimental testing conducted on three railguns. It discusses improvements to the 30-megajoule homopolar generator and 250-kilojoule capacitor bank as well as instrumentation techniques and analysis capabilities. It also describes the planned high energy lab. The 50-mm square bore railgun demonstrated dramatic improvements in barrel wear with solid armatures of proper design. Tests on the short prototype of the 20-mm round bore railgun indicated that the composite structure will withstand the forces involved in the upcoming 5 km/sec tests using plasma armatures. The 50-mm round bore railgun short prototype tests pointed out the difficulties of designing solid round bore armatures and the importance of matching barrel stiffness and armature compliance.

31034 (AD-A-217604/8/XAB) **Nonlinear interaction of intense laser pulses in plasmas. Interim report.** Sprangle, P.; Esarey, E.; Ting, A. Naval Research Lab., Washington, DC (USA). 22 Dec 1989. 38p. (NRL-MR-6545). Available from NTIS, PC A03/MF A01.

A nonlinear 1D theory is developed which describes some important aspects of intense laser-plasma interactions. The self-consistent laser-plasma analysis included nonlinear plasma wakefield generation, relativistic optical guiding, coherent harmonic radiation production, as well as other related phenomena. Relativistic optical guiding is found to be most effective for long laser pulses having slow rise times. Short laser pulses are shown to be weakly guided. Coherent harmonic generation using a linearly polarized laser is found to be most efficient for short laser pulses and can be enhanced by the presence of large amplitude plasma wakefields. Aspects of particle acceleration by laser pulses as well as possible methods for upshifting the frequency of laser pulses are also discussed.

31035 (BNL-52211, pp. 3-11) **Introductory presentation at the shelter island workshop on switched power.** Willis, W. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135-: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

One type of accelerator with time varying fields proposed in the 1920's was the switched power accelerator. At the time the switches were not adequate. Now the timing accuracy is adequate, but that leaves another field quality issue, reproducible spatial distribution. The qualitative evaluation of the field quality problem depends on the geometry of the accelerating structure and quality of the switch, and in the quality of the laser drive in the case of a linear photoswitch. Among the variations in the theme power form impulses, it is noted that the field can be built up by one pulse or a few accurately timed pulses and that the field produced can be in a pulsed form or in a sine-wave packet. Another dimension is the structure used to couple the switch to the beam. A number of options have been considered for the source of impulses. The criteria for choosing among the possibilities for the switch are based on elements of practicality which are under research. 5 figs., 1 tab.

31036 (BNL-52211, pp. 12-43) **Solid state switching.** Lincke, E.T. (Univ. of Rochester, NY (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135-: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

In recent years semiconducting materials, particularly silicon (Si) and gallium arsenide (GaAs) have become very attractive candidates for high voltage high speed switches. They hold off fields in excess of 100 kV/cm for microseconds without breakdown, and if they are illuminated with pulsed laser light whose photon span the band gap of the material these materials can act as a switch that will close as fast as the width of the laser pulse. Switches that close in the subpicosecond range have been demonstrated. One application in which these switches are being used, which is the primary focus of this paper, is the development of a compact high gradient linear accelerator. First the fundamentals of a photoconductive switch (PCS) are described. The laser switched LINAC is described and preliminary results of its performance are presented. A Blumlein circuit is used for the injection of the E-M pulse into the accelerator, so a prototype Blumlein circuit using a laser activated switch was constructed. Results regarding its operation are also presented. Another branch of research being pursued and on which results will be presented are experiments designed to determine the ultimate voltage and switching capabilities of these switches. Finally the current status and future plans of the research are outlined. 9 refs., 25 figs.

31037 (BNL-52211, pp. 238-239) **Introduction.** Palmer, R.B. (Brookhaven National Lab., Upton, NY (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135-: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The search for very high gradient acceleration has been driven to a large extent by the high energy physics community, for the construction of higher energy accelerators. But the needs of this community are more complex than just high gradient: the accelerator must carry relatively cheap. These requirements are not easily met with the high gradient mechanisms we now know. There are however other needs for high gradient that are less demanding and are thus more appropriate at this stage. For instance high brightness electron guns. Since the intent here is to explore the technology for such a gun, it is reasonable not to require a high repetition rate. Something of the order of 1 Hz would be sufficient. As will be seen this makes the demonstration a lot easier. It must be remembered however that for a real FEL or other application, rates of a few hundred Hz would be desirable. 1 ref.

31038 (BNL-52211, pp. 240-242) **Summary of conclusions of the vacuum photodiode working group.** Willis, W. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135-: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

This report presents the design of a 30 MV gun. In considering the design of the vacuum photodiode switched to drive the accelerating field in the gun, we have paid attention to the work of the groups on high-voltage pulsing and on the design of the laser. We have found that we can trade off reduced laser power at the cost of a higher charging voltage for our one stage accelerator. We have presented the various parameter sets to the two groups and attempted to measure their enthusiasm for each set, and we have chosen the set that seems to provide an equal level of difficulty on both sides. 1 fig., 1 tab.

31039 (BNL-52211, pp. 243-247) **Solid state switching summary.** Lincke, E.T. (Univ. of Rochester, NY (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135-: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The summary for the solid state switching group is presented as a proposed accelerator structure using solid state switches to accelerate 8nC of electrons to 3MV across a single 2mm gap 20 times/sec. It is presumed that the electrons have already been generated. The task of this group was to design a structure that can handle these parameters, estimate the power supply requirements, and determine what laser is necessary for such a design. The laser requirements can already be met with current technology, and except for the fast risetime requirements on the high

voltage pulser (which is the subject of study of a separate subgroup at this workshop) a power supply should also be possible for this accelerator design. In conclusion, at the limits of current technology a single stage accelerator with the specifications prescribed should be feasible.

31040 (BNL–52211, pp. 248-249) **Report of the gun working group.** Sheffield, R.; Aronson, S.; Claus, J.; Kirk, H.; Villa, F.; Wurtele, J. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

This paper addresses the switched power gun. The authors estimate the expected transverse emittance which the switched power gun will achieve. They have considered two cases: a high peak current (8 nC/pulse) and a more modest (0.1 nC/pulse). In evaluating the two cases, they adopt reasonable conjectures as to the nature of scaling to the switched power gun case. The high peak current case does not deliver the peak brilliance. 1 tab.

31041 (BNL–52211, pp. 250-256) **Switched power workshop power supply working group.** Haseroth, H.; Hopkins, D.; Ikezi, H.; Kirbie, H.; Lincke, E.; Wilson, M. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The power supply working group was assigned the problem of pulse charging the 3-MeV gun. The gun is a radial line structure that has two charging configurations: a single ring charged to 500 kV or nine rings charged from 100 to 200 kV. In either configuration, the pulsed source must rapidly charge the structure's ring(s) before breakdown can begin. The issues encountered in charging the structure can be divided into two categories. First, the charging system must be well matched to the gun structure. Proper impedance matching will avoid reflections and limit the fault current if the ring should spark. Second, several systems can achieve the wide range of charge voltages necessary. Some are better suited to high voltages, while others are better at low voltages. The following paragraphs will address the impedance matching issues are review three choices for pulse generators. A system for each type of source is described along with a very rough cost estimate. 1 ref., 4 figs., 2 tabs.

31042 (BNL–52211, pp. 263-268) **Summary.** Palmer, R.B. (Brookhaven National Lab., Upton, NY (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Variations on the construction of switched power gun depend on the method of generating the initial radial pulse, which could be by: (1)a laser switched vacuum photodiode; (2) a laser switched solid-state diode; (3) a laser switched high pressure discharge gap; and (4) a high voltage pulse generation by Fourier synthesis form many different rf waves. These are discussed in the reports of the working groups. In all but the last, the critical questions appear to be: (a) providing a short enough pulse of the initial high voltage to avoid breakdown of the switch before the laser pulse and (b) providing sufficient laser power at the required pulse length and frequency. Separate working groups discussed them. A working group also looked at the gun performance that such an accelerating gradient might make possible. 2 refs., 1 fig.

31043 (DOE/ER/40048–235-LO) **Status of and operating experience with the University of Washington superconducting booster linac.** Storm, D.W.; Amsbaugh, J.F.; Corcoran, D.T.; Harper, G.C.; Howe, M.A.; Will, D.I. Washington Univ., Seattle, WA (USA). Nuclear Physics Lab. [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. (CONF-891043–4: SNEAP '89: symposium of northeastern accelerator personnel, Oak Ridge, TN (USA), 22-27 Oct 1989). Order Number DE90010490. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The superconducting linac has been operational for two years. During that time we have gained substantial operating experience with the machine and we have carried out minor upgrades on various systems. The performance of the systems and of the accelerator as a whole is presented. The improvements are described. 4 refs., 4 figs., 1 tab.

31044 (DOE/ER/40150–T1) **CEBAF [Continuous Electron Beam Accelerator Facility] design report.** Continuous Electron Beam Accelerator Facility, Newport News, VA (USA). May 1986. 238p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84ER40150. Order Number DE90010523. Available from NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.

This book describes the conceptual design of, and the planning for, the Continuous Electron Beam Accelerator Facility (CEBAF), which will be a high-intensity, continuous-wave electron linear accelerator (linac) for nuclear physics. Its principal scientific goal is to understand the quark structure, behavior, and clustering of individual nucleons in the nuclear medium, and simultaneously to understand the forces governing this behavior. The linac will consist of 1 GeV of accelerating structure, split into two antiparallel 0.5-GeV segments. The segments will be connected by a beam transport system to circulate the electron beams from one segment to the other for up to four complete passes of acceleration. The maximum beam energy will be 4 GeV at a design current of 200 microamperes. The accelerator complex will also include systems to extract three continuous beams from the linac and to deliver them to three experimental halls equipped with detectors and instrumentation for nuclear physics research. The accelerating structure will be kept superconducting within insulated cryostats filled with liquid helium produced at a central helium refrigerator and distributed to the cryostats via insulated transfer lines. An injector, instrumentation and controls for the accelerator, radio-frequency power systems, and several support facilities will also be provided. A cost estimate based on the Work Breakdown Structure has been completed. Assuming a five-year construction schedule starting early in FY 1987, the total estimated cost is $236 million (actual year dollars), including contingency.

31045 (GSI–90-09(prepr.)) **On the thermoionization in hot cavities.** Kirchner, R. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 17p. Available from Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.).

Thermally equilibrated gases of low pressure are characterized by a high degree of ionization at temperatures easily reached with laboratory devices. This property is generally believed to be the principle behind ion sources of the hot-cavity-type. The necessary condition of thermal equilibrium for the cavity plasma is, however, often very unlikely, though in general tacitly assumed. It is shown that especially in the most widespread application - low pressure operation for isotope separation on-line - the cavity plasma is far off thermal equilibrium. The consequence is that the influence of the cavity parameters (work function, temperature, plasma density and pressure of the neutral particles) on the ionization efficiency is decisively different from what is expected for a thermalized system. (orig.).

31046 **Very high pulse-energy accelerators.** Ramirez, J.J. (Sandia National Laboratories, Albuquerque, NM (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The dominant trend in the development of pulsed power accelerator technology over the last decade has been towards higher power and shorter pulse widths. Limitations in high voltage, high current switch performance, and in power flow through vacuum insulator housings led to the development of highly modular designs. This modular approach requires precise synchronization of the various modules and efficient methods of combining the power from these modules to drive a common load. The need to drive very low impedance loads led to effective ways to combine these modules in parallel. The Particle Beam Fusion Accelerator I (PBFA I) and Saturn are representative of these designs. Hermes III represent a

new approach towards the efficient generation of higher voltages. It is designed to drive a 22-MV, 730-kA, 40-ns electron beam diode and combines conventional, modular pulsed power technology with linear induction accelerator concepts. High-power induction accelerator cavities are combined with voltage addition along a MITL to generate the desired output. This design differs from a conventional linac in that the voltages are added by the MITL flow rather than by a drifting beam that gains kinetic energy at each stage. This design is a major extrapolation of previous state-of-the-art technology represented by the injector module of the Advanced Test Accelerator and has proven to be efficient and reliable. The design and performance of Hermes III are presented together with a discussion of the application of this technology to the light ion beam inertial confinement fusion program. 18 refs., 9 figs.

31047 Heavy-ion superconducting linacs. Delayen, J.R. (Argonne National Laboratory, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper reviews the status of the superconducting heavy-ion accelerators. Most of them are linacs used as boosters for tandem electrostatic accelerators, although the technology is being extended to very low velocity to eliminate the need for an injector. The characteristics and features of the various superconducting heavy-ion accelerators are discussed. 45 refs.

31048 The BEAR [Beam Experiments Aboard Rocket] accelerator. O'Shea, P.G. (Los Alamos National Laboratory, NM (USA)); Butler, T.; Hansborough, L.D.; Lynch, M.T.; McKenna, K.F.; Schrage, D.L.; Shubaly, M.R.; Stovall, J.E.; Zaugg, T.J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Beam Experiments Aboard Rocket (BEAR) accelerator is the major component of an experiment designed to demonstrate the operation of an ion accelerator in space, and to characterize the exoatmospheric propagation of a neutral particle beam. It is the result of an extensive collaboration between Los Alamos National Laboratory and industrial partners, and is designed to produce a 10-mA (equivalent), 1-MeV neutral hydrogen beam in 50-μs pulses at 5 Hz. The accelerator consists of a 30-kV H^- injector, a 1-MeV radio frequency quadruple, and two 425 MHz RF amplifiers, a gas-cell neutralizer, beam optics, vacuum system, diagnostics and controls. The design has been constrained by the need for a lightweight rugged system that would operate autonomously. The accelerator has undergone extensive environmental and operational testing in the laboratory in preparation for launch. The results of testing on the ground test stand are reported here. 12 refs., 7 figs.

31049 184-inch synchrocyclotron decommissioning. Reimers, R. (Univ. of California, Berkeley (USA)); Haley, J.; Hampton, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The 184 was last run on December 29, 1987. Decommissioning work included relocation of Van de Graff and biomedical programs, radiation measurements, planning, estimate preparation, tooling design and procurement, scheduling, shipping arrangements, rigging studies, obtaining of permits, waste disposal coordination, and cleanup. During decommissioning all the cyclotron parts and equipment inside the cyclotron cave were found to have induced radioactivity and were disposed of at the DOE Westinghouse Hanford Company site. Decommissioning has been done safely on budget and schedule. 7 refs.

31050 A two-cyclotron concept for production of radioactive ion beams. Jongen, Y. (Ion Beam Applications, Louvain-la-Neuve (Belgium)); Lacroix, M.; Loiselet, M.; Ninane, A.; Ryckewaert, G.; Zaremba, S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the course of 1986, the idea of using the two cyclotrons, operating in adjacent vaults at the Universite Catholique de Louvain at Louvain-la-Neuve, to measure directly the cross-section at sub-Coulomb energies of a nuclear reaction involving a nucleus with a half-life shorter than one hour, was proposed. The radiative proton capture on ^{13}N (with a half-life of about 10 minutes) was soon selected as an especially interesting representative of that class of reactions. 9 refs., 3 figs.

31051 High luminosity performance of the SPS proton-antiproton collider. Bailey, R. (CERN, Geneva (Switzerland)); Brouzet, E.; Cornelis, K.; Evans, L.; Faugier, A.; Hatton, V.; Miles, J.; Schmidt, R.; Thomas, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In September 1988, the CERN SPS collider was brought into operation for the first physics production run with the improved antiproton production and accumulation complex (AAC). The increased antiproton flux immediately resulted in a considerable improvement in the machine performance with initial luminosities exceeding 2.4 $\times$ 10^{30} cm^{-2} s^{-1} and weekly integrated luminosities an order of magnitude greater than achieved in the past. In this paper, performance statistics and operational experience in this new regime are discussed. 2 refs., 5 figs.

31052 Integral split RFQ structure for heavy ion acceleration. Jia-Xun, Fang (Peking Univ. (China)); Chia-Erh, Chen; Schempp, A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

4-Rod RFQ structure based on the Integral Split-Ring resonator is being studied for the acceleration of heavy ions. The special features of the structure, rf properties and results of beam dynamics calculations and model tests are described. The results show that this structure is well suited for a low frequency heavy ion RFQ, for which parameters of a prototype RFQ accelerator for N^+ are presented. 10 refs., 6 figs., 2 tabs.

31053 ITEP proton synchrotron reconstruction. Alexeev, N.N. (Institute for Theoretical and Experimental Physics, Moscow (Germany, F.R.)); Bolshakov, A.E.; Goldin, L.L.; Nikolaev, V.I.; Onosovsky, K.K.; Piskunov, V.P.; Rjabtsev, A.S.; Veselov, M.A.; Zavodov, V.P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The ITEP 10 GeV Proton Synchrotron (U-10) is now being reconstructed into a proton and ion accelerator complex which would be able to accelerate ions of all atoms with various Z/A values. The first stage of the reconstruction includes construction of an ion injector, of a beam transport line (from the new injector to the synchrotron), and modification of proton synchrotron systems necessary for ion acceleration. In particular, the authors need to change the synchrotron vacuum chamber together with its pumping system to reach 10^{-10} Torr vacuum instead of 10^{-6} Torr now. All these modernizations are, practically, completed. In 1988, first ions of He^{2+} were injected into the synchrotron and accelerated successfully up to the energy 4.3 GeV/A. In this, year the authors are going to try to accelerate some heavier ions obtained from the new injector. As the authors hope, light ions will be accelerated up to 4 GeV/A, and heavy ones (unfully stripped) - up to 1 GeV/A. 5 refs., 3 figs.

31054 Mini-beta insertion and luminosity for the RHIC lattice. Lee, S.Y. (Brookhaven National Laboratory, Upton, NY (USA)); Dell, G.F.; Hahn, H.; Parzen, G.; Ruggiero, A.G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Requirement and implication of the mini-β insertion, where a pair of common quadrupoles are inserted between the interaction point and the first beam crossing dipole, in RHIC lattice is studied. For the heavy ion operation, the authors find that $\beta^* = 1$m can be achieved with a $\pm$5m free space for experimental setup and $\beta = 500$m. The beam size limitation is located at the second beam crossing dipole BC2, where 8cm coil i.d. is considered. When the machine is operating at the proton-heavy ion collision mode, these common quadrupoles should be removed physically in order to let both beams crossing the center line at 3.4 mrad. These mini-β insertion can increase the luminosity by a factor of 2-3. For the proton-proton collision mode, the authors find that $\beta^* = 0.5$m is also operable without the mini-β quadrupoles due to smaller emittance for the proton beam. The corresponding β is 2400m. When the mini-β quads are used, $\beta^* = 0.25$m can be achieved. The ultimate luminosity for the proton-proton collision is of the order of $10^{33}/cm^2sec$, which may be useful in the quest of the B physics studies. 3 refs., 3 figs., 3 tabs.

31055 A $\geq$1.5 TeV superconducting synchrotron design for the Fermilab tunnel. Syphers, M.J. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Edwards, D.A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A design for a new high field superconducting synchrotron to occupy the Fermilab main enclosure is presented. A peak energy in the range of 1.5-1.8 TeV is envisages. Following a brief discussion of the motivation and expected performance of the ring, the layout and lattice design effort is described. By combining the beam transfers and acceleration system in a single straight section a potential third interaction region is acquired. The beam transfers from the Main Injector motivate us to choose a focusing optics reversed in sign from that of the present Tevatron. In order to facilitate beam separation schemes the dispersion function is reduced by increasing the tune and matching the long straight sections to the standard cells in the arcs. 3 refs., 6 figs., 1 tab.

31056 An asymmetric B-meson factory at PEP. Garren, A. (Lawrence Berkeley Laboratory, CA (USA)); Chattopadhyay, S.; Chin, Y.; Oddone, P.; Zisman, M.S.; Donald, M.; Feldman, G.; Paterson, J.M.; Rees, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A preliminary design for a B-factory has been made using asymmetric collisions between positrons in the PEP storage ring and electrons in a new, low-energy ring. The design utilizes small-aperture, permanent-magnet quadrupoles close to the interaction point (IP). Optimization of optical and beam parameters at the IP will be discussed, as well as the lattice design of the interaction region and of the rings. 7 refs., 3 figs., 2 tabs.

31057 Operational experience with heavy ions at BNL: An update. Gardner, C.; Reece, R.K.; Ahrens, L.A.; Barton, D.S.; Beavis, D.; Benjamin, J.; Foelsche, H.; Gill, E.; Raka, E.; Sidhu, S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Since May, 1986, the heavy ion transfer line (HITL) which joins the Tandem Van de Graaff facility and the AGS at Brookhaven National Laboratory has permitted the acceleration of heavy ions (up to sulfur) to 14.5 GeV/nucleon. The Tandem, operating with a pulsed ion source, supplies a fully stripped ion beam at about 7 MeV/nucleon which is transported via the HITL to the AGS. A low frequency rf system accelerates the beam in the AGS to about 200 MeV/nucleon and the high frequency rf system, normally used for proton acceleration, completes the acceleration to 14.5 GeV/nucleon. The high energy ion beams are delivered to four experimental beam lines using standard resonant extraction. Following is an update of the performance and operational characteristics associated with the production, transport, and acceleration of these ion beams. 10 refs., 2 figs., 2 tabs.

31058 Feedback control of the upgraded linac at Fermilab. Owens, T. (Fermilab, Batavia, IL (USA)); Calvo, O.A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The last sixty-four meters of the Fermilab Linear Accelerator will be replaced with seven new higher-frequency, higher field accelerator sections. Each section will be powered by a single 12 MW, 805 MHz klystron. A feedback system will be described which controls the amplitude and phase of the rf fields within the individual accelerator sections. To understand the control loops and to optimize their design, ACSL (Advanced Computer Simulation Language) has been utilized. In the analysis the rf cavities and the klystrons are modeled as single-pole devices. Cavity fields are calculated as the convolution integral of the input phasor and the cavity impulse response. Phase and amplitude loops are coupled and exhibit nonlinearities. Due to the distances between the klystrons and the accelerator sections, delays are considerable. The Smith principle will be examined as a means of improving stability in this situation. 3 refs., 7 figs.

31059 Bevalac versatility: Operations achievements in the multi-tasking mode. Lothrop, F. (Lawrence Berkeley Lab., CA (USA)); Alonso, J.; Miller, R.; Tekawa, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Demand for relativistic heavy ion beams at the Bevalac has increased dramatically in the past two years. To keep pace, the Bevalac makes use of five injectors, precise guide field control, preset beam transport line tunes, nine nuclear science target areas, and three biology/radiotherapy areas, along with elegant control computer algorithms, to achieve high operating efficiency. Routine operation includes as many as ten ion/energy/beamline changes per day, 15 major nuclear science experiments each year, radiotherapy on nearly a daily basis, with biology experiments operating biweekly. High operating efficiency and low failure rates combine to produce high annual research hours. 12 refs., 2 figs.

31060 Recent operational experience with the Fermilab Tevatron. Crawford, J.L. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Mau, R.C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This report summarizes the performance of the Fermilab accelerator complex, particularly the Tevatron, during the two years since the 1987 Particle Accelerator Conference. The accelerator has provided 800 GeV protons for one fixed-target run and 900 GeV protons and anti-protons for two collider runs during this period. Major accomplishments, as well as some of the operational problem areas, are highlighted. 4 refs., 3 figs.

31061 Indirect measurement of HERMES III voltage. Sanford, T.W.L. (Sandia National Laboratories, Albuquerque, NM (USA));

Halbleib, J.A.; Poukey, J.W.; Ramirez, J.J.; Alexander, J.A.; Douglas, G.; Mock, R.; Sheridan, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The peak voltage at the HERMES III diode is measured to be 19 ± 2 MV by three indirect techniques that utilize parapotential flow theory, range of H^- ions, and radiation output. Associated measurements of peak voltage along the MITL support the measured diode voltage and show that HERMES III operates as a balanced system, with each cavity contributing equally to the power pulse at the diode. 10 refs., 6 figs., 1 tab.

31062 Long term ground movement of TRISTAN synchrotron. Endo, K. (National Laboratory for High Energy Physics, Ibaraki-ken (Japan)); Ohsawa, Y.; Miyahara, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The long term ground movement is estimated through the geological survey before a big accelerator is planned. For the case of TRISTAN-MR (main ring), its site was surveyed to reflect the underground information to the building prior to the construction. The movement of the synchrotron magnet mainly results from the structure of the tunnel. If an individual movement of the magnet exceeds a certain threshold limit, it gives a significant effect on the particle behavior in a synchrotron. Height of the quadrupole magnets were observed periodically during past two years at the TRISTAN-MR and their height differences along the 3 km circumference of the accelerator ring were decomposed into the Fourier components depicting the causes of the movements. Results shows the movement of the tunnel foundation which was also observed by the simultaneous measurement of both magnets and fiducial marks on the tunnel wall. The long term movement of the magnets is summarized with the geological survey prior to construction. 1 ref., 6 figs., 1 tab.

31063 Status and outlook for international collaboration on future accelerators. Lederman, L.M. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lingstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

This paper discusses the history and status of the international committee on future accelerators (ICFA. A series of workshops were held aimed at the future of ICFA. The first of these was held in Tokyo in 1984. In the language reminiscent of State Department pronouncements, full and frank discussions took place. Conclusions resulting from the workshops are discussed.

31064 The Stanford Linear Collider. Rees, J.R. *Scientific American (USA)*, 261(4): 58-65 (Oct 1989).

April, 1989, the first Z zero particle was observed at the Stanford Linear Collider (SLC). The SLC collides high-energy beams of electrons and positrons into each other. In break with tradition the SLC aims two linear beams at each other. Strong motives impelled the Stanford team to choose the route of innovation. One reason being that linear colliders promise to be less expensive to build and operate than storage ring colliders. An equally powerful motive was the desire to build an Z zero factory, a facility at which the Z zero particle can be studied in detail. More than 200 Z zero particles have been detected at the SLC and more continue to be churned out regularly. It is in measuring the properties of the Z zero that the SLC has a seminal contribution to make. One of the primary goals of the SLC experimental program is to determine the mass of the Z zero as precisely as possible.In the end, the SLC's greatest significance will be in having proved a new accelerator technology. 7 figs.

31065 Tolerance of imperfections in high-energy circular accelerators for polarized protons. Lee, S.Y. (Accelerator Development Department, Bldg. 1005S, Brookhaven National Laboratory, Associated Universities, Inc., Upton, New York 11973 (US)); Courant, E.D. *Physical Review, D (Particles Fields) (USA)*, 41(1): 292-302 (1 Jan 1990).

Realistic calculations show that imperfection-spin-resonance strengths ϵ_{imp} can be corrected to $\epsilon_{imp}<1$, at 20 TeV, Superconducting Super Collider (SSC) energy. Statistical analysis agrees well with the numerical calculation. The polarized proton must be accelerated through overlapping intrinsic and imperfection resonances. We found a correlation between the tolerable strengths of intrinsic and imperfection resonances ϵ_{int} and ϵ_{imp}, that is, at smaller ϵ_{int}, the tolerable ϵ_{imp} becomes larger, and vice versa. To obtain a larger tolerable ϵ_{imp}, we suggest that the number of snakes should be chosen according to $N_S \geq 5\epsilon_{int}$. When a large number of snakes is used in the accelerator, the tolerable deviation of the spin rotational angle from 180° for each snake becomes more stringent. The error in the spin rotation angle gives rise to (1) an equivalent picket-fence imperfection resonance ϵ_{imp}^{eq} and (2) an energy-dependent spin tune ν_s. Both of these effects may cause depolarization. Further, when the snake axis is not properly arranged, the spin tune deviates from half-integer. In this case, depolarization may arise from the snake resonances. Our analysis indicates that acceleration of polarized protons in the SSC is technically feasible if care is taken in constructing the snakes.

31066 Linear induction accelerator and pulse forming networks therefor. Buttram, M.T.; Ginn, J.W. To U.S. Dept. of Energy, Washington, DC. USA Patent 4888556/A/. 19 Dec 1989. Filed date 21 Jun 1988. USA Patent Application 7-209,398. Int. Cl. H05H 9/00. vp.

This patent describes a linear induction accelerator of an electron beam. It comprises: a pulse current source consisting of a constant current source; switch means for alternately switching the output of the current source between either first or second terminals and ground; and at least one bipolar converting means, connected between the first terminal and ground, for converting the pulsed current at the first terminal into a bipolar high-voltage, square wave pulse train having a pulse of a first polarity when the output is connected to the second terminal, and a pulse of a second, opposite, polarity when the output is connected to the first terminal; a matching impedance connected to the second terminal, the impedance at each of the first and second terminals being equal; and cavity means, connected between the first terminal and ground, for accelerating the electron beam during the pulse of a first polarity and for resetting the cavity during the pulse of a second polarity.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 31146, 31154, 31160, 31188, 31202, 31246, 31262, 31752, 31957

31067 (ANL-HEP-CP–90-05) **Wakefield calculations on parallel computers.** Schoessow, P. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-900163–8: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90009712. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The use of parallelism in the solution of wakefield problems is illustrated for two different computer architectures (SIMD and MIMD). Results are given for finite difference codes which have been implemented on a Connection Machine and an Alliant FX/8 and which are used to compute wakefields in dielectric loaded structures. Benchmarks on code performance are presented for both cases. 4 refs., 3 figs., 2 tabs.

31068 (LA-UR–90-1247) **New BEDLAM [BEam Dynamics for Linear Accelerators by Moments].** Lysenko, W.P.; Channell, P.J. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900163–7: Accelerator computer code meeting, Los Alamos, NM (USA), 22-25 Jan 1990). Order Number DE90010572. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

BEDLAM (BEam Dynamics for Linear Accelerators by Moments) is a 3-D code that simulates bunched ion beams in linear accelerators and beamlines. The BEDLAM beam is described by moments

of the phase-space distribution, and the evolution of these moments is what is computed. In this approach, the beam, the external focusing forces, and the space-charge forces are all described consistently to the same order of accuracy. The present version of BEDLAM includes moments up to fourth order (equivalent to a third-order conventional optics code), just as in the previous version. The new features are an improved space-charge model and the use of a Lie-Poisson integrator, which provides the code the stability that symplectic integrators give to particle codes. 3 refs.

31069 (SLAC/AP–79) **On the directional symmetry of the impedance.** Heifets, S.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC05-84ER40150. Order Number DE90010685. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The independence of the impedance on the beam direction is an important feature of an accelerator structure, in particular, for the electron-positron storage rings where bunches of opposite charges travel through the same vacuum chamber in opposite directions. Recently Gluckstern and Zotter considered a cylindrically symmetric but longitudinally asymmetric cavity with side pipes of equal radii. They were able to prove that for a relativistic particle the longitudinal impedance of the cavity with an arbitrary shape is independent of the direction in which the beam travels through it. Their result corroborates numerical observations of the independence of the wakefield obtained with the code TBCI. Bisognano gave an elegant proof of the same statement. His approach is based on a reciprocity relation applied to the tensor Green's function. I follow here his idea in a somewhat simpler way to obtain more general and physically transparent proof of this property for both longitudinal and transverse impedances. The result is valid for a cavity with no azimuthal symmetry and for arbitrary particle velocity, as soon as it may be considered constant. At the same time the limits of its validity are shown.

31070 (SLAC-PEP-NOTE–382) **ZAP study of collective effects in PEP: 9 × 9 collider optics.** Corbett, W.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90010684. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this note, single and multi-bunch collective instabilities are considered for PEP operating a 9 × 9 bunch configuration. The lattice is based on a vertically separated beam 'pretzel' design which allows for collisions at the TPC (IR2) only. Threshold current levels and linear instability growth rates are calculated with the storage ring design code 'ZAP'. Single bunch instabilities should not be a problem for total circulating currents of 100mA (18 bunches, 5.6mA/bunch). Coupled-bunch growth rate calculations are based on a line broadening technique for the higher-order cavity modes. In the longitudinal case, feedback will be required. For the transverse coupled bunch instabilities, growth rates are about 5 times less. 14 refs., 5 figs.

31071 (SLAC-PUB–5177) **Bunch lengthening in the SLC [Stanford Linear Collider] damping rings.** Bane, K.L.F. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8910357–2: Impedance and bunch instability workshop, Argonne, IL (USA), 31 Oct - 1 nov 1989). Order Number DE90010174. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A high level of current dependent bunch lengthening has been observed on the North damping ring of the Stanford Linear Collider (SLC). At currents of 3×10^{10} this behavior does not appear to degrade the machine's performance significantly. However, at the higher currents that are envisioned for the future one fears that its performance could be greatly degraded due to the phenomenon of bunch lengthening. This was the motivation for the work described in this paper. In this paper we calculate the longitudinal impedance of the damping ring vacuum chamber. More specifically, in this paper we find the response function of the ring to a short Gaussian bunch, which we call the Green function wake. In addition, we try to estimate the relative importance of the different vacuum chamber objects, in order to see how we might reduce the ring impedance. This paper also describes bunch length measurements performed on the North damping ring. We use the Green function wake, discussed above, to compute the bunch lengthening. Then we compare these results with those obtained from the measurements. In addition, we calculate the current dependence of the tune distribution.

31072 Review of beam dynamics experiments and issues in large colliders. Edwards, D.A. (Fermilab, Batavia, IL (USA)); Syphers, M.J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The nonlinear dynamics of transverse particle oscillations are being studied experimentally with several large synchrotrons. In the FNAL Tevatron and the CERN SpS, sextupole magnets are used as the sources of nonlinear forces. Studies are also being performed in the FNAL Main Ring at its injection energy, an inherently nonlinear environment. Here, the authors present a brief review of these studies. The authors conclude with a discussion of field quality and aperture issues in large hadron colliders. 13 refs., 7 figs.

31073 Differential algebra - a new tool. Berz, M. (Lawrence Berkeley Laboratory, CA (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An overview of the theory and implementation of the differential algebraic method is presented. The method allows a very straightforward computation of Taylor maps of beamlines. Contrary to older techniques, the method is not restricted to low order and allows the study or arbitrarily many variables, including system parameters. The resulting Taylor maps offer a variety of useful applications, including fast short term tracking, the computation of generating functions which can be used for symplectic tracking, as well as the direct computation of tuneshifts, smear, and approximate invariants. References to more detailed literature are given. 24 refs.

31074 Modeling the SSC. Schachinger, L. (Lawrence Berkeley Laboratory, CA (USA)); Paxson, V.; Sun, T.; Hinkins, R.; Talman, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An interactive, graphical simulation has been developed which is being used to design operational procedures and correction algorithms for the SSC. All algorithms use only measurable quantities to calculate corrector strengths, and thus are suitable for correcting a real accelerator. This strategy has been successfully applied to establishment of first turn, global orbit correction, global decoupling, and systematic multipole correction. In all cases, several different sources of error were included in the simulations, in order to take into account the effects of collusion between errors. 6 refs., 3 figs.

31075 Measurement of β in the TEVATRON and comparisons with calculations. Gelfand, N.M. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Johnson, R.P.; Zhang, P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A computer model of the Tevatron based on the tracking code TEVLAT has been developed. The model incorporates the basic lattice structure of the Tevatron, the correction elements and the high order multipoles of the Tevatron dipoles and quadrupoles, as measured at cryogenic temperatures at the Fermilab Magnet Test

Facility. The model also includes the nominal closed orbit distortions. Measurements of the lattice amplitude function β will be compared with the values calculated by the model. 4 figs., 4 tabs.

31076 Nonlinear dynamics experiments in the Tevatron. Merminga, N. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Edwards, D.; Finely, D.; Gerig, R.; Gelfand, N.; Harrison, M.; Johnson, R.; Syphers, M.; Meller, R.; Siemann, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Results of the continuing analysis of the nonlinear dynamics experiment E778 are presented. Sixteen special sextupoles introduced nonlinearities in the Tevatron. Smear, which is one of the parameters used to quantify the degree of nonlinearity, was extracted from the data and compared with calculation. Injection efficiency in the presence of nonlinearities was studied. Measurements of the dynamic aperture were performed. The final results in one degree of freedom of the smear, the injection efficiency and the dynamic aperture are presented. Particles captured on nonlinear resonance islands were directly observed and measurements were performed. The capture efficiency was extracted from the data and compared with prediction. The influence of tune modulation on the stability of these islands was investigated. Plans for future measurements are discussed. 4 refs., 6 figs.

31077 Multipole correction in synchrotrons. Neuffer, D. (Los Alamos National Laboratory, NM (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

New methods of correcting dynamic nonlinearities resulting from the multipole content of a synchrotron are presented and discussed. In a simplest form, correction elements are placed at the center (C) of the accelerator half-cells as well as near the focusing (F) and defocusing (D) quadrupoles. In a first approximation, the corrector strengths follow Simpson's Rule. The F, C, and D correctors also permit direct control of horizontal, coupled, and vertical motion. for example, second-order sextupole nonlinearities can be corrected with F, C, and D octupoles. Generalizations and variations of the methods are described and applications to the SSC, LHC, AHF, and HERA projects are discussed. Correction by three or more orders of magnitude can be obtained and simple solutions to a fundamental problem in synchrotrons are demonstrated. 13 refs., 2 figs., 1 tab.

31078 Analytical estimates of coupling in damping rings. Raubenheimer, T.O. (Stanford Univ., CA (USA)); Ruth, R.D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In this paper the authors present analytic formulas to estimate the vertical emittance in weakly coupled electron/positron storage rings. We consider contributions from both the vertical dispersion and linear coupling of the betatron motions. In addition to simple expressions for random misalignments and rotations of the magnets, formulas are presented to calculate the vertical emittance blowup due to orbit distortions. The orbit distortions are assumed to be caused by random misalignments, but because the closed orbit is correlated from point to point, the effects must be treated differently. The authors consider only corrected orbits. Finally, the analytic expressions are compared with computer simulations of storage rings with random misalignments. 6 refs., 3 figs.

31079 A beam characterization of H^- particles. Hassan, A.A. (Argonne National Laboratory, IL (USA)); Fink, C.L.; Rosing, M.G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A pinhole-scintillator diagnostics system has been developed to determine the characteristics of a 50-MeV H^- beam. The device consists of an aluminum plate (1.27 mm thick) with a series of pinholes (125 μm diameter) covered by a thin neutralizer foil and downstream scintillator plate and associated camera. The foil covered pinholes produce a series of H^0 beamlets that are detected downstream by the scintillator plate. The use of H^0 particles provides the ability to measure the beam parameters without changing the magnetic fields of downstream magnetic elements. Measurement of the intensities of the beamlets, the separations between beamlets, and the beamlet width allow determination of the beam parameters. The H^+, produced by the plate, are sufficiently scattered by the plate, such that a sweep magnet is not required. The device has been used at the Argonne National Laboratory (ANL) Neutral Particle Beam Test Stand (NPBTS) to measure the parameters at the input of the beam expanding telescope. 4 refs., 6 figs.

31080 Energy measurement from betatron oscillations. Himel, T. (Stanford Univ., CA (USA)); Thompson, K. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the Stanford Linear Collider the electron beam is accelerated from 1-50 GeV in a distance of 3 km. The energy is measured and corrected at the end with an energy feedback loop. There are no bends within the linear accelerator itself, so no intermediate energy measurements are made. Errors in the energy profile due to misphasing of the RF, or due to calibration errors in the klystrons' RF outputs are difficult to detect. As the total betatron phase advance down the accelerator is about $30 \times 2\pi$, an energy error of a few percent can cause a large error in the total phase advance. This in turn degrades the performance of auto-steering programs. The authors have developed a diagnostic program which generates and measures several betatron oscillations in the accelerator. It then analyzes this oscillation, looking for frequency changes which indicate energy errors. One can then compensate for or correct these energy errors. 6 refs., 1 fig.

31081 Beamstrahlung as an optics tuning tool at the SLC IP. Gero, E. (Univ. of Michigan, Ann Arbor (USA)); Bonvicini, G.; Koska, W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The phenomenology of beamstrahlung radiation is discussed, with an emphasis on its application to extracting the beam sizes from the observed signals and on monitoring the beam-beam collision in a nondisruptive manner. The calculations used include such effects as unequal beam sizes and aspect ratios, beam-beam offsets and beam orientation. Techniques for finding the beam parameters in both the cases of beams that are round or elliptical in the transverse plane are also discussed. 1 ref., 4 figs.

31082 HESYRL 200 MeV Linac single bunch energy spectra measurement. Yin, Yan (Univ. of Science and Technology of China, Hefei, Anhui (China)); Wang, Defa. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

HESYRL 200 Mev electron Linac was finished in Dec. 1987, and has been running well since then. A careful study on single bunch energy spectrum for the Linac was done. The measurement shows the energy spread of the Linac is $\pm 0.4\%$. The measurement is described in this paper. 1 fig.

31083 Monitoring the conditions of beam injection into the IHEP accelerator from the Booster. Brook, V.L. (IHEP, Serpukhov (USSR)); Mamuchasvili, N.G.; Morozov, I.G.; Tereschenko, I.N.; Tishin, V.G.; Shekhvatov, S.V. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The beam is injected into the IHEP accelerator 29 times per cycle, each time filling one unfilled bucket. The purpose of our work was to measure the parameters of betatron (H and V) oscillations, as well as of dipole and quadrupole synchrotron ones of the burst just injected. The measurements results are processed on-line to transform them into the machine parameters. Then the correction data and statistical information characterizing the parameter stability are displayed. These allow one to make a prompt and comprehensive tuning of the two machines with a view to minimize the oscillation amplitude. A specific feature of the measuring equipment is the necessity to record the parameters of one bunch specified among a number of those circulating in the accelerator. 3 refs.

31084 Automatic Steering corrections to minimize injection oscillations in the Fermilab antiproton source rings. Harding, D.J. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Riddiford, A.W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Missteering of a particle beam at injection into a circular accelerator produces coherent betatron oscillations. The beam position monitor system in the Antiproton Source at Fermilab can measure the beam position one each turn around the ring during these oscillations. From the amplitude and phase of the oscillations, corrections to the beamline steering are calculated to remove the oscillations. The analysis includes the case where the horizontal and vertical tunes are quite strongly coupled. This technique has proved to be valuable both in operation to the Fermilab Collider and as an analytical tool. 4 refs., 2 figs.

31085 Operational experience with model-based steering in the SLC linac. Thompson, K.A. (Stanford Univ., CA (USA)); Himel, T.; Moore, S.; Sanchez-Chopitea, L.; Shoaee, H. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Operational experience with model-driven steering in the linac of the Stanford Linear Collider is discussed. Important issues include two-beam steering, sensitivity of algorithms to faulty components, sources of disagreement with the model, and the effects of the finite resolution of beam position monitors. Methods developed to make the steering algorithms more robust in the presence of such complications are also presented. 5 refs., 1 fig.

31086 A new closed orbit correction procedure for the CERN SPS. Herr, W. (CERN, Geneva (Switzerland)); Limberg, T.; Miles, J.; Schmidt, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Using well known correction techniques and algorithms, the authors have built a new procedure to correct the closed orbit of the CERN SPS. The option to steer beam lines has been included allowing the establishment and optimization of the first turn in the machine. As a new feature this correction procedures can take into account limited corrector strength. Apart from necessary enhancements to the algorithms, the authors have defined a new data interface between the programs involved to achieve high flexibility and language independence and to increase its efficiency. The correction procedure is described in detail and the performance is discussed using results from simulations and its first application during the lepton commissioning period and the $\overline{pp}$ collider run in 1988. 4 refs., 1 fig., 4 tabs.

31087 Beam-beam effects in electron and proton colliders. Keil, E. (CERN, Geneva (Switzerland)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This review of beam-beam effects in electron and proton colliders is divided into two main parts, the first devoted to electron-positron colliders and the second to proton-antiproton colliders. Both parts start with a discussion of recent observations in existing colliders. The part on electron-positron colliders continues with a discussion of the frequencies of the coherent oscillations of the rigid bunches coupled by the beam-beam forces, and concludes with a discussion of the several attempt to understand the nature of the beam-beam interaction theoretically. The part on proton-antiproton colliders continues with an interpretation of the observations in terms of the tune spreads present in the colliding beams, and concludes with a discussion of the observed distribution functions. 28 refs., 4 figs., 3 tabs.

31088 Experiments on intense electron beam transport in mesh focusing arrays. Ekdahl, C. (Los Alamos National Lab., NM (USA)); Humphries, S. Jr. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors describe recent experiments on the transport of high-current relativistic electron beams in vacuum using wire-mesh focusing. The authors observed self-contained propagation of 44 kA beams at a maximum energy of 3 MeV - the corresponding value of v/γ was $\approx$0.4. The experiments are a one-hundred-fold extrapolation of beam power over the authors previous agreement with theory. The results show that mesh focusing has application to the most intense electron beams presently available from pulsed power generators. 6 refs., 5 figs.

31089 Comparison of Gabor lens, gas focusing, and electrostatic quadrupole focusing for low-energy ion beams. Reiser, M. (Univ. of Maryland, College Park (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

When a particle beam propagates through a background gas, a plasma is formed by collisional ionization resulting in (partial) neutralization of the beam's space charge and decrease of the beam radius. This gas focusing effect occurs naturally and is often utilized to improve high-current beam transport. Gabor, in 1947, proposed a nonneutral electron plasma confined in a magnetron-type trap as an effective space-charge lens for positive ion beams. This Gabor lens, which offers better control and focusing strength than both gas focusing and applied fields, has been investigated by several research groups since its invention. So far, however, the experimental results have been inconclusive. In this paper, the authors will present a theoretical reevaluation of the Gabor lens and a comparison with an electrostatic quadrupole (ESQ) doublet. It will be shown that the focusing strength of the Gabor lens depends on the electron trapping efficiency and is significantly higher than that of the ESQ doublet if the trapping efficiency is close to the theoretical Brillouin limit. On the other hand, an ESQ doublet with equivalent geometry and voltage parameters performs better than the Gabor lens if the trapping efficiency is below a certain threshold, as appears to be the case in experiments so far. 16 refs., 2 figs.

31090 Longitudinal emittance in high-current linear ion accelerators. Wangler, T.P.; Bhatia, T.S.; Neuschaefer, G.H.; Pabst, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume

3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The control of longitudinal emittance in an ion linear accelerator is important for minimizing both chromatic aberrations and beam halo. The root-mean-square (rms) longitudinal emittance growth can result from either the nonlinear rf focusing fields or the nonlinear space-charge fields. The authors will present conclusions based on numerical beam-dynamics studies for both the radio-frequency quadrupole (RFQ), and the drift-tube linac (DTL). The authors will discuss the scaling of longitudinal emittance produced during the adiabatic bunching in an RFQ and will show the benefits of ramped DTL accelerating field designs to maintain high longitudinal focusing strength with increasing particle energy. 15 refs., 8 figs.

31091 The effects of insertion devices on the beam dynamics in the ALS. Jackson, A. (Lawrence Berkeley Laboratory, CA (USA)); Forest, E.; Nishimura, H.; Zisman, M.S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Third generation synchrotron radiation sources, such as the Advanced Light Source (ALS), are specifically designed to operate with long undulators that produce very high brightness beams of synchrotron radiation. Including such devices in the storage ring magnet lattice introduces extra linear and nonlinear fields that are intrinsic to the undulator. These fields break the symmetry of the lattice and provide driving forces for nonlinear resonances, thereby perturbing the dynamics of the electron motion, particularly at large amplitudes. The main impact of these perturbations is on the beam lifetime, arising out of a reduction of both the transverse acceptance and the momentum acceptance. In this paper, the authors present the results of an ongoing study of these effects as they relate to the performance of the ALS 7 refs., 7 figs., 2 tabs.

31092 Analysis of RF modes in the ANL APS vacuum chamber using computer simulation, electron beam excitation and perturbation techniques. Kustom, R. (Argonne National Laboratory, IL (USA)); Bridges, J.; Chou, W.; Cook, J.; Mavrogenes, G.; Nicholls, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The APS vacuum chamber consists of a nearly elliptical beam chamber coupled to an antechamber through a 1-cm-high, 10-cm-long pumping slot over most of the 1104 m of storage ring circumference. A cross section in a plane perpendicular to the beam direction is shown in Fig. 1. Nonevaporable getter (NeG) strips in the antechamber are the pumping element. The 1-cm-high slot has two functions: to provide good conductance for vacuum pumping and for transmission of the photons into the beam ports. The authors thought that coupling of the beam to the antechamber might occur through the slot. Since the beam fields are transverse magnetic to the beam (TM_z), no coupling occurs below the TM cutoff of the slot (15 GHz for 1 cm) because no wall currents are interrupted. Also, the frequency spectrum of a rigid bunch is well below 15 GHz. Both computer calculations and measurements were done to verify that no coupling occurs. In addition to those earlier studies, a real-time MAFIA-T3[6] study in 3D was done, and a measurement of modes excited by a 38-ps, 20-MeV electron beam has been completed. These results are the primary topic of this paper. Some measurements made with a network analyzer and bead perturbation equipment will also be discussed. 8 refs., 11 figs.

31093 Polarized proton acceleration at the KEK PS. Sato, H. (Nagoya Univ. (Japan)); Hiramatsu, S.; Toyama, T.; Arakawa, D.; Mori, Y.; Ikegami, K.; Takagi, A.; Ueno, A.; Ohmori, C.; Holt, J.A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The KEK PS consists of a 750 KeV Cockcroft-Walton preinjector, a 40 MeV injector linac, a 500 MeV booster synchrotron and a 12 GeV main ring synchrotron. Both the booster and the main ring of the KEK PS are strong focusing synchrotrons and therefore strong depolarizing resonances are expected during acceleration. Research and development of polarized proton beam acceleration is being carried out at the KEK PS, and approximately 40% and 25% polarization has been obtained at 3.5 GeV and 5.0 GeV, respectively, in the main ring. In this article, the performance of the polarized proton beam acceleration and the origin of the depolarization in the booster will be described. 15 refs., 7 figs.

31094 Asymptotic growth of cumulative and regenerative beam break-up instabilities in linear accelerators. Lau, Y.Y. (Naval Research Laboratory, WA (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

With the use of a simple model, it is shown that the asymptotic growth of the cumulative beam break-up instability is independent of the linear transverse focusing. The analysis is extended to include the transition from the cumulative to the regenerative type, both in the presence and absence of a focusing magnetic field. 17 refs., 1 fig.

31095 Real time closed orbit correction system. Yu, L.H. (Brookhaven National Laboratory, Upton, NY (USA)); Biscardi, R.; Bittner, J.; Bozoki, E.; Galayda, J.; Krinsky, S.; Nawrocky, R.; Singh, O.; Vignola, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors describe a global closed orbit feedback experiment, based upon a real time harmonic analysis of both the orbit movement and the correction magnetic fields. The feedback forces the coefficients of a few harmonics near the betatron tune to vanish, and significantly improves the global orbit stability. The authors present the result of the experiment in the UV ring using 4 detectors and 4 trims, in which maximum observed displacement was reduced by a factor of between 3 and 4. 4 refs., 3 figs.

31096 Radiative polarization in high-energy storage rings. Mane, S.R. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Electron and positron beams circulating in high-energy storage rings become spontaneously polarized by the emission of synchrotron radiation. The asymptotic degree of polarization that can be attained is strongly affected by so-called depolarizing resonances. Detailed experimental measurements of the polarization were made SPEAR about ten years ago, but due to lack of a suitable theory only a limited theoretical fit to the data has so far been achieved. The author presents a general formalism for calculating depolarizing resonances, which has been coded into a computer program called SMILE, and use it to fit the SPEAR data. By the use of suitable approximations, the author is able to fit both higher order and nonlinear resonances, and thereby to interpret many hitherto unexplained features in the data, and to resolve a puzzle concerning the asymmetry of certain resonance widths seen in the data. 18 refs., 2 figs.

31097 Studies and calculations of transverse emittance growth in high-energy proton storage rings. Mane, S.R. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Jackson, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3.

Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the operation of proton-antiproton colliders, an important goal is to maximize the integrated luminosity. During such operations in the Fermilab Tevatron, the transverse beam emittances were observed to grow unexpectedly quickly, thus causing a serious reduction of the luminosity. The authors have studied this phenomenon experimentally and theoretically. A formula for the emittance growth rate, due to random dipole kicks, is derived. In the experiment, RF phase noise of known amplitude was deliberately injected into the Tevatron to kick the beam randomly, via dispersion at the RF cavities. Theory and experiment are found to agree reasonably well. The authors briefly discuss the problem of quadrupole kicks. 14 refs., 2 figs., 3 tabs.

31098 Space-charge effects in the Fermilab Main Ring at 8 GeV. Mane, S.R. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The author uses computer tracking to investigate the effects of space-charge on particle motion in the Fermilab Main Ring at $p = 8$ GeV/c. The results are found to agree with the Laslett tuneshift formula. Simple model cases are also studied to speed up the tracking. The effects of synchrotron oscillations, via tune modulation and dispersion, are included. 2 refs., 5 figs.

31099 Stratonovich expansion and beam-beam interactions. Hirata, Kohji (CERN, Geneva (Switzerland)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A general prescription is proposed for the study of coherent phenomena in electron storage rings due to a localized nonlinear force. The prescription is based on expanding the distribution function into a series using generalized Hermite polynomials in two dimensions (Stratonovich expansion). When the series is terminated at the lowest order, it gives the Gaussian approximation. The prescription is applied to strong-strong and weak-strong beam-beam interactions in e^+e^- colliding storage rings at the next-to-lowest order application. 6 refs., 3 figs.

31100 Helical orbit studies in the Tevatron. Goderre, G.P.; Malamud, E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Tevatron is currently running very close to the beam-beam limit. Therefore, in order to increase the luminosity the proton and antiproton beams have to be separated to eliminate unwanted beam crossings. To achieve this beam-beam separation the proton and antiproton beams must travel on separate helical orbits, except at the collision areas. Particles moving on helical orbits in the Tevatron have both their tune and coupling changes with no measurable change in their chromaticity or lifetime. The tune and coupling changes are due to b_2 multipole errors in the main bending magnets. The size of the changes depends on the phase of the helical orbit relative to the distribution of b_2 errors around the ring. For the upgraded Tevatron with separated orbits the protons and antiprotons live on different helical orbits. Therefore, the antiprotons are tune shifted relative to the protons by ~ 0.01 in both the horizontal and vertical planes, and experience a different skew quadrupole field (Q_s) of $\sim 0.2 \times 10^{-2}$ m^{-1}. These differences can be removed by suitably located sextupoles whose feed down normal and skew quadrupole terms cancel the equivalent effect produced by the b_2 feed down of the main bending magnets. 1 ref., 2 figs.

31101 Luminosity lifetime in the Tevatron collider. Herrup, D.A. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Finley, D.; Jackson, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors have measured the luminosity lifetime of the Tevatron under a variety of conditions. The authors present results for the lifetimes and analyze them in terms of the contributions from various sources of emittance growth and intensity lifetimes. The authors have used these data to make improvements to the Tevatron which have resulted in longer luminosity lifetimes. 6 refs., 3 figs., 2 tabs.

31102 Calculation of integrated luminosity for beams stored in the Tevatron Collider. Finley, D.A. (Fermi National Accelerator, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A model for calculating the integrated luminosity of beams stored in the Tevatron collider will be presented. The model determines the instantaneous luminosity by calculating the overlap integral of bunched beams passing through the interaction region. The calculation accounts for the variation in beam size due to the beta functions and also for effects due to finite longitudinal emittance and non-zero dispersion in the interaction region. The integrated luminosity is calculated for the beams as they evolve due to processes including collisions and intrabeam scattering. The model has been applied to both the extant and upgraded Tevatron collider, but is not limited to them. 5 refs., 2 figs., 4 tabs.

31103 Dynamics of heavy ion beams during longitudinal compression. Ho, D.D.M. (Lawrence Livermore Nat. Lab., Livermore, CA (US)); Bangerter, R.O.; Lee, E.P.; Brandon, S.; Mark, J.W.K. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

Heavy ion beam with initially uniform line charge density can be compressed longitudinally by an order of magnitude in such a way that the compressed beam has uniform line charge density and velocity-tilt profiles. There are no envelope mismatch oscillations during compression. Although the transverse temperature varies along the beam and also varies with time, no substantial longitudinal and transverse emittance growth has been observed. Scaling laws for beam radius and transport system parameters are given.

31104 On the optimization of ion microprobes. Shao, Z. (Department of Physics and Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637 (US)); Wang, Y.L. *Journal of Vacuum Science and Technology, B: Microelectronics Processing and Phenomena (USA)*, 8(1): 95-99 (Jan 1990).

The size of an ion probe is determined by many different factors such as virtual source size, magnification, probe current, and aberrations of its optical column. While operating or designing an ion optical system, it is often desirable to choose these parameters such that the optimum probe is obtained for the anticipated application. In this paper, we propose a routine which could be used to find the optimum magnification and aberrations of a system for given ion source parameters and probe requirements.

31105 Gabor lens focusing of a proton beam. Palkovic, J.A. (Fermi National Accelerator Laboratory, Box 500, MS 307, Batavia, Illinois 60510 (US)); Mills, F.E.; Schmidt, C.; Young, D.E. *Review of Scientific Instruments (USA)*, 61(1): 550-552 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Gabor or plasma lenses have previously been used to focus intense beams of positive ions at energies from 10 keV to 5 MeV.

Such lenses are a possible candidate for matching an intense low-energy proton beam into a radio frequency quadrupole accelerator (RFQ). The conventional solution has been to match an intense beam with two solenoid lenses. This leads to a time-dependent emittance at the RFQ entrance due to neutralization effects. The neutralization time of a space-charge dominated 30–50 mA proton beam in the Gabor lens is <1 μs. A non-neutral electron plasma is contained in the Gabor lens by a 200 G solenoid magnet. The equivalent thin lens focal length of a Gabor lens operated at Fermilab has been determined to be 10 cm. This focusing strength is adequate for matching a proton beam into an RFQ.

31106 Beam dynamics of a liquid-metal ion source. Wheaton, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (US)); Meszaros, P.S.; Rothe, K.E.; Raridon, R.J.; Ryan, P.M. *Review of Scientific Instruments (USA)*, 61(1): 568-570 (Jan 1990). DOE Contract AC05-84OR21400. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

rms emittance growth of liquid-metal ion sources is studied. Processes included are nonlinear expansion through extractor and accelerator fringe fields, nonlinear beam space charge, plasma effects near needle, and waves [either ion acoustic or space charge limited as considered by Dudnikov (private communication, 1988)]. This investigation consists of 2-D analysis of appropriate Vlasov–Poisson equations in both steady-state and time-dependent formulations. Various geometries will be considered such as some used by Alton of ORNL.

31107 Numerical simulation of collective ion acceleration in an intense electron beam–localized gas cloud system. Yao, R.L. (Laboratory for Plasma Research—Department of Electrical Engineering, University of Maryland, College Park, Maryland 20742 (US)); Striffler, C.D. *Journal of Applied Physics (USA)*, 67(4): 1650-1658 (15 Feb 1990).

In experiments in which an intense relativistic electron beam is injected into an evacuated drift tube with a localized gas cloud located near the anode, ions with energies several times the electron beam energy have been observed. These experiments have been simulated using a particle-in-cell code which realistically models ionization of the gas. It was found that when the injected electron beam current exceeds the space-charge limiting current, ions are accelerated to energies several times the electron beam energy by coherent motion of the ions and the intense virtual cathode electric fields. The dependence of the peak ion energy on the system parameters as observed in the simulations is also discussed. For the parameter regimes investigated with beam energies up to 3 MV, beam currents up to 35 kA, gas pressures up to 600 mTorr, and gas cloud widths up to 6 cm, peak ion energies of 5–6 times the electron beam energy have been observed.

31108 Dynamics of electron flow in extended planar-anode diode operating at 19 MV and 700 kA. Sanford, T.W.L.; Halbleib, J.A.; Poukey, J.W.; Baldwin, G.T.; Carlson, G.A.; Stygar, W.A.; Mastin, G.A.; Sheridan, T.; Mock, R.; Alexander, J.A. *Journal of Applied Physics (USA)*, 67(4): 1700-1711 (15 Feb 1990). DOE Contract AC04-76DP00789.

The electron flow in a planar-anode diode having an extended anode-cathode gap operating on the HERMES III accelerator is characterized and compared with predictions of a computational model. The model combines a particle-in-cell code with Monte Carlo radiation transport. The comparisons confirm the model and show that the diode provides both a matched load and a versatile large-area source of γ rays for the study of nuclear radiation effects. Electrical and spatial parameters of the beam at the diode and the downstream radiation fields from a graphite target are presented as a function of the anode-cathode gap.

4303 Auxiliaries and Components

Refer also to citation(s) 31035, 31036, 31037, 31038, 31039, 31040, 31041, 31042, 31058, 31061, 31085, 31086, 31241, 31242, 31243, 31244, 31245, 31247, 31248, 31249, 31250, 31251, 31252, 31253, 31254, 31256, 31257, 31260, 31261, 31264, 31706, 31766, 31963, 31964, 31969, 31970, 31986

31109 (BNL–44470) **The High Flux Beam Reactor instrument upgrade.** Axe, J. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9002100–2: International Group on Research Reactors conference, Knoxville, TN (USA), 28 Feb - 2 mar 1990). Order Number DE90010019. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A brief overview is given of the current status of the High Flux Beam Reactor, including the ongoing safety review, and of plans for the upgrade of the instruments on the experimental level. 2 figs.

31110 (BNL–44473) **Emittance measurements on a volume H^- ion source.** Alessi, J.G. Brookhaven National Lab., Upton, NY (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891055–16: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90010123. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A current of 30 mA has been extracted from a volume production H^- source having a toroidal discharge chamber and rotational symmetry. This is a current density of 30 mA/cm^2. The emittance measurement gave a normalized, 90% value of $\epsilon_N(90\%) = 0.32$ π mm-mrad for a 13 mA beam. The ion temperature is estimated to be 0.57 eV for this case. For 25.5 mA, $\epsilon_N(90\%) = 1.11$ π mm-mrad was measured, but the true value is most likely smaller due to a limitation in the emittance resolution. 6 refs., 4 figs., 1 tab.

31111 (BNL–44516) **Evaluation of SSC cable produced for the model dipole program during 1989 and through February, 1990.** Christopherson, D. (Lawrence Berkeley Lab., CA (USA)); Hannaford, R.; Remsbottom, R.; Scanlan, R.M.; Garber, M. Brookhaven National Lab., Upton, NY (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (LBL–28700;CONF-900348–4: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90010648. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

During 1989 and the beginning of 1990, approximately 150,000 feet of cable was manufactured for use in the SSC Model Dipole Magnet Program. The wire for the cable was made to SSC specifications by three different manufacturers. The cable was made at New England Electric Wire on the SSC Production Cabling Machine, under supervision of either SSC Laboratory personnel or the wire manufacturer's representative. All the cable produced for SSC model dipoles was subjected to rigorous inspection in order to insure that the magnet construction and performance would be predictable. The cable dimensions were measured at intervals of 10 feet or less with a cable measuring machine. Electrical properties were measured on samples from one end of each cable length. Critical current degradation due to cabling was checked by measuring the critical currents of the wires used to make the cable and comparing these with the cable critical current. The results of the dimensional and electrical measurements will be discussed and compared with the SSC specification requirements. 4 refs., 6 figs., 2 tabs.

31112 (BNL–52211, pp. 44-69) **UV photoemission from metal cathodes for picosecond power switches.** Fischer, J.; Srinivasan-Rao, T.; Tsang, T. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Results are reported of photoemission studies laser pulses of 10 ps duration and 4.66 eV photon energy on metal cathodes. These included thin wires, flat surfaces and an yttrium cathode with a grainy surface. The measurements of current density and quantum efficiency under low and high surface fields indicate that field assisted efficiencies exceeding 0.1% and current densities exceeding 10^5 A/cm^2 are obtainable. The results are compared to the requirements of switch power applications. 24 refs., 13 figs., 1 tab.

31113 (BNL–52211, pp. 70-81) **High speed switching in gases.** Cassell, R.E. (Stanford Univ., CA (USA)); Villa, F.

Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

A fast, efficient and reliable switch is the basic ingredient of a pulse power accelerator. The authors examine high speed switching in gases. A simple calculation predicts extremely high rate of rise for the current in a switch working in a high pressure gas, triggered by some electrons released by a very short pulse laser. The energy required to drive this switch is much smaller than the energy needed for the other two candidates, the solid state semiconductor and the photocathode. The authors calculations agree well with a more complex, fluid in cell code. 12 refs., 12 figs.

31114 (BNL–52211, pp. 82-110) **Field enhanced photodiode.** Boussoukaya, M. (Universite Paris XI (France)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Pulsed field enhanced photoemission from single or from arrays of metallic or semiconducting needles is one of the possible methods which may lead to the realization of a very high emissive and bright e^- source. In many laboratories of different countries as Brookhaven National Laboratory and Los Alamos National Laboratory in U.S.A., KEK in Japan, LAL in France and others, studies on the development of new photoelectron sources triggered by laser light beams are under way. The main goal of theses researches is the production of picosecond electron pulses of 5×10^{-9} to 2×10^{-8} C/bunch with the same frequency as the light modulation and which can be used as direct injector for new accelerators, free electron lasers, RF power sources, etc... Many results are already obtained, however there is still some difficulties to find the right photocathode and to choose the kind of the emission. At LAL, Orsay (France) our principal interest was to study pulsed photo field emission properties of single and array microemitters with nanosecond and picosecond laser beams operated in the ultra-violet, green and infrared wave length regions of the electromagnetic radiation spectrum. Photoemitted current densities of 10^{10} and 10^8 A/cm^2 were obtained from single tungsten needle and carbon array emitters respectively in the ps and ns regimes. Quantum yields exceeding unity were obtained in both regimes. Explanation of such high quantum yields is strongly tied to the field effect and to other physical properties of the microemitters. 9 refs., 24 figs., 1 tab.

31115 (BNL–52211, pp. 111-137) **Conversion to fields.** Stumer, I. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The author presents a numerical evaluation of the fields generated by the Switched Power Linac. The purpose of the study is to find out the characteristics of the fields in the vicinity of the photocathode. as a starting point, the authors consider the geometry proposed by W. Willis. The proposed geometry was simulated with the program MASK. The electromagnetic pulse was found to have rise time of 3 psecs and wavelength of 1 cm. The study shows that a flat photocathode is preferred to a wire type. 3 refs., 23 figs.

31116 (BNL–52211, pp. 138-156) **Radial transmission lines.** Caspers, F. (CERN, Geneva (Switzerland)); Haseroth, H.; Knott, J.; Willis, W.; Aronson, S. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The principle of the switched power Linac (SPL) has raised considerable interest. Work is going on in different laboratories concerning its various aspects. At CERN, model measurements were performed to study the enhancement factors and the field distribution around the accelerating gap. Multifrequency operation to achieve similar effects has also been tested. This paper reviews the work done at CERN over the laser few years.

31117 (BNL–52211, pp. 157-161) **Some further thoughts on high gradients to be achieved with multifrequency excitation of a cavity.** Caspers, F. (CERN, Geneva (Switzerland)); Haseroth, H. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

In the context of model measurements for the switched power Linac the idea came up to achieve high gradients by multifrequency excitation of a cavity. Compression in space and time of the electric field can be achieved by superposition of different frequencies (the eigen-frequencies of the cavity) with appropriate relative phases. The paper reviews some of the technical problems of this scheme. 3 refs., 1 fig.

31118 (BNL–52211, pp. 162-183) **A new switched power linac structure.** Villa, F. (Stanford Univ., CA (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Pulse power differs form RF only to the extent that the power compression stage of a resonant cavity is replaced by fast switching. The two approaches are, in essence, the same. Pulse power eliminates the very expensive and complicated conversion from wall plug to RF energy and lends itself quite naturally to the acceleration of very short bunches. This paper is devoted to the description of a new pulse power structure, and to the proposal for a switching technique that appears to fill the requirements of future high gradient machines. 13 refs., 6 figs., 2 tabs.

31119 (BNL–52211, pp. 191-218) **Picosecond and femtosecond laser systems for particle accelerator applications.** Donaldson, W.R. (Univ. of Rochester, NY (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

This report will outline work done at the University of Rochester's Laboratory for Laser Energetics on the generation of high energy femtosecond optical pulses. These types of lasers may be used as drivers for a switched power linac. It will be divided into three parts. The first will examine the two most common methods by which short optical pulses are generated, i.e., direct generation by modelocking and indirectly by pulse compression techniques. Although these techniques generate short optical pulses, the energy in those pulse is generally quite small. The second section will deal the problems and methods of amplifying short optical pulses. The third section will describe progress in laser and optical materials which promise significant improvements for the future. 13 refs., 19 figs.

31120 (BNL–52211, pp. 219-235) **Magnetic switching.** Kirbie, H.C. (Lawrence Livermore National Lab., NM (USA)). Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop.* Order Number DE90008712. Available from NTIS, PC A12/MF A01.

Magnetic switching is a pulse compression technique that uses a saturable inductor (reactor) to pass pulses of energy between two capacitors. A high degree of pulse compression can be achieved in a network when several of these simple, magnetically switched circuits are connected in series. Individual inductors are designed to saturate in cascade as a pulse moves along the network. The technique is particularly useful when a single-pulse network must be very reliable or when a multi-pulse network must operate at a high pulse repetition frequency (PRF). Today, magnetic switches trigger spark gaps, sharpen the risetimes of high energy pulses, power large lasers, and drive high PRF linear induction accelerators. This paper will describe the technique of magnetic pulse compression using simple networks and design equations. A brief review of modern magnetic materials and of their role in magnetic switch design will be presented. 12 refs., 8 figs., 1 tab.

31121 (BNL–52211, pp. 257-262) **Laser working group.** Bigio, I.J. (Los Alamos National Lab., NM (USA)); Kurnit, N.A.;

Donaldson, W.R.; Geissler, K.; Srinivasan-Rao, T. Brookhaven National Lab., Upton, NY (USA). 1988. (CONF-8810135–: Switched-power workshop, Shelter Island, NY (USA), 16-21 Oct 1988). In *Proceedings of the switched power workshop*. Order Number DE90008712. Available from NTIS, PC A12/MF A01.

The laser working group considered several options to deliver synchronized laser pulses of the required energy to the photocathode and laser triggered switches. Some development work may be required to provide a system that has the desirable characteristics of stability, ease of use and low maintenance. The baseline concept utilizes doubled Nd:YAG-pumped dye oscillator/amplifiers to produce an upconverted picosecond pulse that can be amplified to tens of mJ in a KrF excimer laser. A fraction of the dye oscillator output is also compressed by means of a fiber-grating compressor and further amplified in a dye amplifier before being upconverted to produce the synchronized pulse for the photocathode. Several variations on this baseline concept were investigated. All of the alternatives discussed require on the order of $300 K in capital equipment and probably at least double that amount in manpower. A choice may depend on availability of some of the equipment as well as more detailed assessments of the practicality of the other approaches. 9 refs., 1 fig.

31122 (BONN-IR–89-45) **Use of VME computers for the data acquisition system of the PHOENICS experiment.** Zucht, B. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Oct 1989. 48p. (In German). Order Number DE90784925. Available from NTIS (US Sales Only), PC A03/MF A01.

The data acquisition program PHON (PHOENICS ONLINE) for the PHOENICS-experiment at the stretcher ring ELSA in Bonn is described. PHON is based on a fast parallel CAMAC readout with special VME-front-end-processors (VIP) and a VAX computer, allowing comfortable control and programming. Special tools have been developed to facilitate the implementation of user programs. The PHON-compiler allows to specify the arrangement of the CAMAC-modules to be read out for each event (camaclist) using a simple language. The camaclist is translated in 68000 Assembly and runs on the front-end-processors, making high data rates possible. User programs for monitoring and control of the experiment normally require low data rates and therefore run on the VAX computer. CAMAC operations are supported by the PHON CAMAC-Library. For graphic representation of the data the CERN standard program libraries HBOOK and PAW are used. The data acquisition system is very flexible and can be easily adapted to different experiments. (orig.).

31123 (CEA-CONF–9952) **Developments of Hom couplers for superconducting cavities.** Mosnier, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire. 1989. 19p. (CONF-8908145–: 4. workshop on RF superconductivity, Ibaraki-Ken (Japan), 14-18 Aug 1989). Order Number DE90784655. Available from NTIS (US Sales Only), PC A03/MF A01.

Coherent instabilities limit the beam current. They are mainly caused by the long range wakefields excited by the beam bunches as they passed through the cavities. The best way to increase the threshold is to damp the Higher Order Modes of the cavities once the shunt impedances are fixed. Typical Q values under 10^5 or 10^4 for the most dangerous parasitic modes are required in present designs of accelerators. Various devices have been developed. The main differences lie in the type of coupling - hole, probe or loop - and in the way of rejecting the accelerating mode. But all the last versions couple through the beam tube and not directly in the cells. The risk of multipacting and also of thermal breakdown is thus avoided. However care must be taken in the design of cavities with the so-called trapped modes, for which though above cut-off, the field goes rapidly to zero outside the cavity.

31124 (CNIC–00244) **The drive system of 100 MeV electron linear accelerator.** Sun Yuzhen (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Su Guoping; Wang Xiulong; Tianlu. China Nuclear Information Centre, Beijing, BJ (China). Jun 1988. 6p. (In Chinese). (IAE–0056). Order Number DE90626760. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The principle, structure, measurement results and technical performances of microwave drive system for 100MeV electron linear accelerator are presented. In this system the peak power of 15 kW is produced by the S bank middle power klystron. The output power of the klystron is divided into six subdrive lines that drive six high power klystrons respectively. The results show the system with simple structure and good characteristics completely meets the requirements of 100 MeV Linac.

31125 (CONF-890802–27) **Modeling the performance of water and liquid gallium cooled x-ray optical components: A comparison with experiment.** Chrzas, J.; Khounsary, A.M.; Mills, D.M.; Viccaro, P.J. Argonne National Lab., IL (USA). Dec 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 7. synchrotron radiation instrumentation (SRI) national conference; Berkeley, CA (USA); 6-10 Aug 1989. Order Number DE90010460. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Thermal and structural analyses of a water or liquid gallium cooled silicon crystal x-ray monochromator subjected to high heat loads have been carried out using a finite element method. From the computed strain distributions in the crystal rocking curves were produced and compared with experimentally measured rocking curves. Good agreement between the general width and shape of the calculated and measured rocking curve profiles was obtained. This initial agreement between calculation and measurement provides the foundation for the extension of our modeling to the prediction of x-ray optical component performance with more complex cooling schemes. Such elaborate cooling techniques may be required for the increased power loadings that will be produced by insertion devices in the next generation of low emittance storage ring sources such as the Advanced Photon Source (APS) to be constructed at Argonne National Laboratory. 5 refs., 6 figs.

31126 (CONF-8910121–5) **Internal polarized targets.** Kinney, E.R. (Argonne National Lab., IL (USA)); Coulter, K.; Gilman, R.; Holt, R.J.; Kowalczyk, R.S.; Napolitano, J.; Potterveld, D.H.; Young, L.: Mishnev, S.I.; Nikolenko, D.M. Argonne National Lab., IL (USA). [1989]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 6. topical conference on physics with polarized beams on polarized targets; Spencer, IN (USA); 16-18 Oct 1989. Order Number DE90010578. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Internal polarized targets offer a number of advantages over external targets. After a brief review of the basic motivation and principles behind internal polarized targets, the technical aspects of the atomic storage cell will be discussed in particular. Sources of depolarization and the means by which their effects can be ameliorated will be described, especially depolarization by the intense magnetic fields arising from the circulating particle beam. The experience of the Argonne Novosibirsk collaboration with the use of a storage cell in a 2 GeV electron storage ring will be the focus of this technical discussion. 17 refs., 11 figs.

31127 (FNAL-TM–1654) **Self-propelled in-tube shuttle and control system for automated measurements of magnetic field alignment.** Boroski, W.N. (Fermi National Accelerator Lab., Batavia, IL (USA)); Nicol, T.H.; Pidcoe, S.V.; Zink, R.A. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900348–2: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90008210. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A magnetic field alignment gauge is used to measure the field angle as a function of axial position in each of the magnets for the Superconducting Super Collider (SSC). Present measurements are made by manually pushing the through the magnet bore tube and stopping at intervals to record field measurements. Gauge location is controlled through graduation marks and alignment pins on the push rods. Field measurements are recorded on a logging multimeter with tape output. Described is a computerized control system being developed to replace the manual procedure for field alignment measurements. The automated system employs a pneumatic walking device to move the measurement gauge through the bore tube. Movement of the device, called the Self-Propelled In-Tube Shuttle (SPITS), is accomplished through an integral, gas driven, double-acting cylinder. The motion of the SPITS is transferred to

the bore tube by means of a pair of controlled, retractable support feet. Control of the SPITS is accomplished through an RS-422 interface from an IBM-compatible computer to a series of solenoid-actuated air valves. Direction of SPITS travel is determined by the air-valve sequence, and is managed through the control software. Precise axial position of the gauge within the magnet is returned to the control system through an optically-encoded digital position transducer attached to the shuttle. Discussed is the performance of the transport device and control system during preliminary testing of the first prototype shuttle. 1 ref., 7 figs.

31128 (LA-UR–90-1142) **Radiation effects concerns at a spallation source.** Sommer, W.F. Los Alamos National Lab., NM (USA). [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9003100–4: International workshop on cold neutron sources, Los Alamos, NM (USA), 5-8 Mar 1990). Order Number DE90010567. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Materials used at spallation neutron sources are exposed to energetic particle and photon radiation. Mechanical and physical properties of these materials are altered; radiation damage on the atomic scale leads to radiation effects on the macroscopic scale. Most notable among mechanical-property radiation effects in metals and metal alloys are changes in tensile strength and ductility, changes in rupture strength, dimensional stability and volumetric swelling, and dimensional changes due to stress-induced creep. Physical properties such as electrical resistivity also are altered. The fission-reactor community has accumulated a good deal of data on material radiation effects. However, when the incident particle energy exceeds 50 MeV or so, a new form of radiation damage ensues; spallation reactions lead to more energetic atom recoils and the subsequent temporal and spatial distribution of point defects is much different from that due to a fission-reactor environment. In addition, spallation reactions cause atomic transmutations with these new atoms representing an impurity in the metal. The higher-energy case is of interest at spallation sources; limited detailed data exist for material performance in this environment. 35 refs., 13 figs., 1 tab.

31129 (NAC-AR–86-01, pp. 56-72) **The separated-sector cyclotron: Extraction.** . National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

During the past year the completion of the extraction system received high priority. The electrostatic extraction channel (EEC) and the first and second septum magnets (SPM1 and SPM2) have been manufactured, installed and tested. Field measurements were carried out on SPM1 and SPM2. Performance of all three extrac tion components was satisfactory. The power supplies for these components have been delivered and tested. Voltages up to 120 kV were achieved across a 15mm gap in the EEC, and current densities up to 180 A/mm^2 in the septum conductors of SPM2 did not pose any cooling problems. Beam extraction from the SSC can be accomplished during the next beam acceleration trials. 15 figs.

31130 (SLAC-PUB–5205) **Detector background conditions at linear colliders.** Jacobsen, R.; Band, H.; Barklow, T.; Burke, D.; Coupal, D.; DeStaebler, H.; Feldman, G.; Hertzbach, S.; Kofler, R.; Kozanecki, W. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC03-76SF00515. Grant: PHY-8701610. (CONF-9003150–2: 5. international conference on instrumentation for colliding beam physics, Novosibirsk (USSR), 15-21 Mar 1990). Order Number DE90010175. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Detector backgrounds at the Stanford Linear Collider are discussed with emphasis on their sources, and methods of controlling them. 5 refs., 7 figs.

31131 **Recording multiple signals on a single waveform recorder.** Boyer, W.B (Sandia National Labs., Albuquerque, NM (USA)); Bouchier, F.A; Mattson, C.R. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

In this paper the authors discuss the data acquisition system for the PBFA II accelerator which records up to 3 signals on each of 64 LeCroy 6880 waveform recorders by separating the signals in time. The time separation is done using both the natural delay times in the accelerator and delay cables. Fast switches must be used to gate the signals to the recorder only during the time of interest. Phillips Scientific model 744 Quad Linear Gated Fan-in/Fan-out NIM modules are being used to switch the signals. Several problems with these switches had to be solved. The switches have a DC thermal drift and a nonlinear transfer function. This requires using a programmable function generator to measure and correct for the switch/6880 amplitude transfer function. The switches have a .1ω output impedance. This produces spurious signals on recorded waveforms due to reflections from small deviations from 50ω at the 6880 input. This problem was solved using a 5X attenuator at the switch output. A capitalize new model 7145 switch which the authors assert should solve some of the problems encountered with the 744 was introduced.

31132 **Proto II triaxial electron beam diode research.** Hedemann, M.A. (Sandia National Labs., Albuquerque, NM (USA)); Pregenzer, A.L.; Lee, J.R.; Leeper, R.J.; Bailey, J.E.; Gustwiller, J.S.; Spence, P.W.; Kishi, H. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

In this paper, the authors discuss research on the Proto II triaxiale electron beam diode research. The Proto II accelerator has been modified to provide electron beams diode loads for bremsstrahlung radiation production. Stable, reproducible operation has been established over a voltage range of 0.5 to 1.5 MV with diode power up to 5 TW. The electron beam diode consists of two nested triaxial diodes which operate independently due to transit time isolation of the power flow. Both current balance and prepulse levels have been found to be critical to the operation of the diodes. Water switching spreads between the 8 modules of up to 15 ns do not impair diode performance. Ion currents due to popular flow have been measured and are relatively low, consistent with triaxial diode models. Radiation output has been measured and compared with radiation transport code calculations. At the highest operating voltage, peak dose rates of $> 1.2 \times 10^{12}$ rad(SI)/s over > 250 cm^2 (2:1 uniformity) are routinely obtained in radiation pulses with a full-width, half maximum (FWHM) of 22 ns.

31133 **Saturn: A large area x-ray simulation acceleration.** . Bloomquist, D.D. (Sandia National Labs., Albuquerque, NM (USA)); Stinnett, R.W.; McDaniel, D.H.; Lee, J.R.; Sharpe, A.W.; Halbleib, J.A.; Schlitt, L.G.; Spence, P.W.; Corcoran, P. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

This article introduces Saturn, the result of a major metamorphosis of the Particle Beam Fusion Accelerator-I (PBFA-I) from an ICF research facility to a large-area x-ray source. Renamed Saturn, for its unique multiple-ring diode design, the facility is designed to take advantage of the numerous advances in pulsed power technology made by the ICF program in recent years and much of the existing PBFA-I support system. Saturn will include significant upgrades in the energy storage and pulse-forming sections.

31134 **Pulsed power requirements for the Sandia recirculating electron beam linac.** Tucker, W.K. (Sandia National Labs., Albuquerque, NM (USA)); Shope, S.L.; Hasti, D.E. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Compact, high gradient, linear induction accelerators may be achieved by recirculating the electron beam in phase with a repeating accelerating voltage. A two-cavity recirculating accelerator has been designed and operated in a single-pass mode. The prototype accelerator uses a 2.5-MV, 20-kA, 25-ns duration injector and an accelerating cavity that will produce a total accelerating voltage of 5.3 MV for four passes. The design of this machine involved key areas of development in pulsed power, specifically low-jitter spark gaps and vacuum-liquid interfaces for bipolar electric fields. The extension of this technology to multiple-pulse machines will require advances in liquid dielectric breakdown strength and switch surface flashover, as well as additional improvements in lower inductance switching and vacuum-liquid interface flashover. This paper discusses the recirculation concept, pulsed-power design parameters, and machine scaling relationships that are valid for state-of-the-art and near- term pulsed-power parameters. The authors summarize the pulsed-power and beam transport experiments.

31135 **Self-magnetically insulted transmission line (MITL) system design for the 20-stage Hermes-III accelerator.** Pate, R.C. (Sandia National Labs., Albuquerque, NM (USA)); Patterson, J.C.; Dowdican, M.C.; Ramirez, J.J.; Hasti, D.E.; Tolk, K.M.; Poukey, J.W.; Schneider, L.X.; Rosenthal, S.E.; Sanford, T.W.L. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The Hermes-III MITL is a coaxial waveguide structure that is divided into two functional regions: A 12.8-m long voltage adder section, and a 4.6-m long isolator/extension section. The adder MITL provides the means for the series addition of the input voltages from the individual cavity feeds. The isolator/extension MITL provides efficient power transport and isolation from the output of the adder section to a bremsstrahlung diode. This paper describes the Hermes- III MITL and presents the electrical design methodology, models, and results obtained for optimum system operation.

31136 **Hermes-III prototype cavity tests.** Johnson, D.L. (Sandia National Labs., Albuquerque, NM (USA)); Ramirez, J.J.; Huddle, C.W.; Denison, G.J.; Franklin, T.L.; Seamons, L.O.; Schlitt, L.; Smith, I. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

The Hermes-III accelerator has twenty 1-MV, inductively isolated cavities connected in series through a high voltage, magnetically insulated transmission line (MITL) to produce a 20-MV, 800-kA pulse that drives a bremsstrahlung diode. Each cavity is 4 m in diameter and weighs nearly 8000 kg when filled with its insulating transformer oil. Cores of pre- annealed Metglas 2605CO are used to inductively isolate the cavities. Azimuthal transmission lines mix inputs from four pulse-forming lines; this reduces the effect of pulse-forming line jitter on the cavity output pulse. A single, prototype cavity has been tested on the system test facility (STF). The test results and comparisons with design specifications and circuit simulations are presented.

31137 **High brightness immersed source injector characterization.** Frost, C.A. (Sandia National Laboratories, Albuquerque, NM (USA)); Poukey, J.W.; Leifeste, G.T.; Hasti, D.E.; Jojola, J.M.; Jones, E.E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

RADLAC II is a high current linear induction accelerator for electrons. The beam is produced in a field-immersed foilless diode injector. We report the first time-resolved characterization of a similar high brightness immersed diode source using a time-gated, 2-D x-ray imaging technique. The experiments were performed on the 4-MeV IBEX accelerator and produced currents exceeding 40 kA in a 6-mm radius, thin annular beam. For currents of 30 kA, even brighter beams were obtained. At lower currents, beams as small as 2 mm in radius were produced with a smaller cathode tip. In all cases, the measured parameters were consistent with 2-D PIC simulations. The experimental results will be discussed and compared to theory and simulations. 7 refs., 10 figs., 1 tab.

31138 **A beam scraper using a linear motor.** Beadle, E.R. (Associated Univ., Inc., Upton, NY (USA)); Rodger, E.S.; Thern, R.E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A beam scraper using a linear motor drive has been developed for use in the AGS at Brookhaven National Laboratory. The device is used to measure beam size by moving a target to a predetermined location and measuring the intercepted beam with nearby loss monitors or by noting the decrease in the circulating beam current. This device has excellent vacuum characteristics, as the motor and sensor coils are outside the vacuum, coupled magnetically to the moving parts which, are inside. There are no bellows or dynamic seals required. The position-time profile is controlled by a closed-loop servo system which uses position feedback. 2 refs., 4 figs.

31139 **The upgraded ring loss radiation monitoring system at the AGS.** Bennett, G.W. (Associated Univ., Inc., Upton, NY (USA)); Beadle, E.; Castillo, V.; Witkover, R.L. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

With the Booster the AGS will accelerate protons to 3×10^{13} per cycle, polarized protons at 10^{12}, and ions from Carbon to Gold at intensities from 50 to 3×10^{9}. A loss monitoring system is being developed to facilitate tuning, and to reduce personnel radiation exposure by minimizing residual induced activity and by allowing remote monitoring of activity in the accelerator enclosure. The monitoring system must have a large dynamic range to monitor high intensity beam losses and to measure induced activity down to the level of a few mrad/hour. Various detectors are being evaluated, including ion chambers, proportional counters, and aluminum cathode electronmultipliers. Measurements of the prompt ionization distribution in the median plane at various energies from point targets at two representative locations in the accelerator lattice have been completed. Details of the monitoring system will be presented, as well as the experimental measurements of the prompt radiation field, and a comparable Monte Carlo calculation. 2 refs., 5 figs.

31140 **A Schottky receiver for non-perturbative tune monitoring in the Tevatron.** Martin, D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Cliff, P.; Fellenz, B.; Horton, B.; Jackson, G.; McConnell, D.; Shafer, R.; Siemann, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Transverse Schottky noise and coherent betatron modulation of the bunched beam revolution harmonics are continuously monitored by a sensitive receiver. The electronics relies upon low noise amplifiers, narrow-band filters, and spectrally pure oscillators to obtain a minimum detectable signal of -160 dBm. Dynamic range is 80 dB. Separate baseband proton and antiproton signals are continuously analyzed in the Main Control Room. 3 refs., 4 figs.

31141 **A resonant beam detector for Tevatron tune monitoring.** Martin, D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Fellenz, B.; Hood, C.; Johnson, M.; Shafer, R.; Siemann, R.; Zurawski, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical

and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: ' 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An inductively resonated, balanced stripline pickup has been constructed for observing tune spectra. The device is a sensitive betatron oscillation and Schottky noise pickup, providing 25dB gain over untuned detectors of like geometry. The electrodes are motorized so the device center and aperture may be remotely adjusted. To tune the resonator onto the 21.4 MHz operating frequency, a motorized capacitor is employed. Quadrature signals from a pair of detectors has enabled observation of individual p and $\bar{p}$ coherent motions to nanometer levels. 9 refs., 5 figs.

31142 A beam-profile monitor for the BNL Accelerator Test Facility (ATF). Russell, D.P. (Princeton Univ., NJ (USA)); McDonald, K.T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A beam-profile monitor has been designed to diagnose the 5-MeV high-brightness electron beam from the rf gun of the BNL Accelerator Test Facility (ATF). The monitor consists of a phosphor screen viewed by a CCD camera. The video images are digitized and stored by a framegrabber and analyzed by an IBM PC-AT to extract the emittance. Details of the hardware configuration are presented, along with the spatial resolution of the system measured as a function of phosphor-screen thickness. The strategies which will be used to measure the transverse and longitudinal emittances are briefly mentioned. The system should be capable of measuring a transverse geometric emittance of around 1 mm-mrad, as will be typical of the ATF beam. 6 refs., 2 figs.

31143 Single bunch intensity monitoring system using an improved wall current monitor. Moore, C.D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Crisp, J.; Howard, D.; Kerns, Q.; Martin, P.; McConnell, D.; Michals, P.; Payne, J.; Tawzer, S.; Webber, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Important parameters in collider operations are the length and intensity of individual beam bunches. A system to automatically measure these parameters has been developed using a wall current monitor signal digitized by a 1 GHz sampling oscilloscope under microprocessor control. Bunch length and intensity are computed by the microprocessor and presented to the host computer. To verify the required accuracy, attention has been paid to the calibration and frequency response of the system. Design and performance of a new wall current monitor with improved bandwidth is presented. 4 refs., 3 figs.

31144 The beam profile measurement system at the Bates linac. Jacobs, K.D. (MIT Bates Linear Accelerator Center, Middleton, MA (USA)); Biron, R.D.; Flanz, J.B.; Ihloff, E.E.; Kelsey, J.E.; Radouch, Z.; Russ, T.; Saab, A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A linac beam profile measurement system using wire scanners has been implemented at the Bates Linear Accelerator Center. This facilitates obtaining an optimum linac focusing solution. A nearly non-invasive beam size measurement is made of the two beams which are accelerated simultaneously in the recirculating linac. The wire scanner mechanical accuracy is near one mil. Beam size measurements are reproducible to a few mils. 4 refs., 7 figs.

31145 Emittance measurements at the Bates linac. Jacobs, K.D. (MIT Bates Linear Accelerator Center, Middleton, MA (USA)); Flanz, J.B.; Russ, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An emittance measuring system has been installed at the Bates Linear Accelerator Center. The system consists of three wire scanners used to measure the electron beam profile, plus a microcomputer for data acquisition and processing. The scanners are located in a drift space on a beam line. Each scanner measures the horizontal and vertical beam size with a possible resolution of 25 μm. The horizontal and vertical beam phase spaces can then be determined. Results of measurements are represented here. Calculations relating the theoretical accuracy of the emittance measurements with the distance separating the scanners, and the location and size of the beam waist, are also presented. Another technique for measuring emittance has also been employed. This technique involves using a wire scanner to measure the beam size at a fixed location, as a function of the strength of an upstream quadrupole. 3 refs., 6 figs.

31146 Observations of the transverse and longitudinal nature of the Fermilab linac beam. McCrory, E. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Owens, T.; Schmidt, C.; Carlson, K.; Walhl, L. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The installation of non-intercepting beam position monitors in the 200 MeV linac at Fermilab has facilitated several new observations on the character of the linac beam. The authors have discovered, in particular, two interesting phenomena: a high frequency ($\approx$ 3MHz) change in the beam position and a slow variation in the phase-lock loops during a 30μs beam pulse. The authors are also making progress in initiating the so-called Δ-t measurement. 7 refs., 3 figs.

31147 Design of the AGS booster beam position monitor system. Beadle, E. (Brookhaven National Laboratory, Upton, NY (USA)); Brennan, J.M.; Ciardullo, D.J.; Savino, J.; Stanziani, V.; Thomas, R.; Zwienen, W.V.; Witkover, R.L.; Schulte, E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The AGS Booster beam position monitor system must cover a wide range of beam intensity and bunch length for proton and heavy ion acceleration. The detector is designed to maintain 0.1 mm local tolerance following 300°C bakeout. The electronics will be located in the tunnel, communicating via fiber optic links to avoid ground loops. The design will be described and test results for prototype units presented. 5 refs., 4 figs.

31148 Beam-loss monitors in the SLC final focus. Jacobsen, R.G. (Stanford Univ., CA (USA)); Mattison, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Beam-loss monitors in the SLC Final Focus System are used for protection of accelerator and detector components, optimizing adjustment of beam halo collimators, and as diagnostics of beam size and halo. Construction of a variety of monitors based on discrete ion chambers, proportional tubes, continuous ion chambers, and signals from the Mark II detector is reported. The interfaces to the SLC control system, the Mark II detector data acquisition system, and the SLC machine protection system are discussed. Experience with the system during SLC commissioning and operation is presented. 10 refs., 5 figs.

31149 Precision synchrotron radiation detectors. Levi, M. (Lawrence Berkeley Laboratory, Berkeley, CA (USA)); Rouse, F.; Butler, J.; Jung, C.K.; Lateur, M.; Nash, J.; Tinsman, J.; Wormser, G.; Gomez, J.J.; Kent, J. pp. 678 of Proceedings of the 1989 IEEE

(Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Precision detectors to measure synchrotron radiation beam positions have been designed and installed as part of beam energy spectrometers at the Stanford Linear Collider (SLC). The distance between pairs of synchrotron radiation beams is measured absolutely to better than 28 μm on a pulse-to-pulse basis. This contributes less than 5 MeV to the error in the measurement of SLC beam energies (approximately 50 GeV). A system of high-resolution video cameras viewing precisely-aligned fiducial wire arrays overlaying phosphorescent screens has achieved this accuracy. Also, detectors of synchrotron radiation using the charge developed by the ejection of Compton-recoil electrons from an array of fine wires are being developed. 4 refs., 5 figs., 1 tab.

31150 Precision measurements of the SLC reference magnets. Watson, S. (Univ. of California, Santa Cruz (USA)); Levi, M.; Nash, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Two spectrometers, one on each extraction line of the SLC, have been installed to momentum analyze each SLC beam pulse and determine the electron and positron beam energies. A method of determining and monitoring the absolute magnetic field strength for these dipoles has been developed. A total error on the magnetic field integral of $\delta \int Bdl / \int Bdl = 1 \times 10^{-4}$ has been achieved. The field integral can be monitored continuously during SLC beam operation using radiation hardened equipment. The laboratory field mapping techniques and the field monitoring methods are described. 6 refs., 4 figs., 5 tabs.

31151 Precision measurements of the SLC beam energy. Kent, J. (Univ. of California, Santa Cruz (USA)); King, M.; Von Zanthier, C.; Watson, S.; Levi, M.; Rouse, F.; Bambade, P.; Erickson, R.; Jung, C.K.; Nash, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A method of precisely determining the beam energy in high energy linear colliders has been developed using dipole spectrometers and synchrotron radiation detectors. Beam lines implementing this method have been installed on the Stanford Linear Collider. An absolute energy measurement with an accuracy of better than $\delta E/E = 5 \times 10^{-4}$ can be achieved on a pulse-to-pulse basis. The operation of this system will be described. 4 refs., 3 figs., 1 tab.

31152 Compact emittance scanners for MeV particle beams. O'Shea, P.G. (Los Alamos National Laboratory, NM (USA)); Zaugg, T.J.; Hansborough, L.D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Compact electric sweep emittance scanners have been previously described for low energy ion beams. New scanners have recently been developed to operate in the MeV range without a significant increase in physical size. These scanners are suitable for the analysis of electron and ion beams. The scanners have excellent angular resolution despite their compact dimensions. Electrical and mechanical design and scaling parameters are presented. Operational experience with a 1 MeV, 25 mA, 50 μs H^- beam is discussed. 5 refs., 5 figs.

31153 Fail-safe ion chamber errant beam detector tailored for personnel protection. Plum, M.A. (Los Alamos National Laboratory, NM (USA)); Browman, A.A.; Brown, D.; Lee, D.M.; McCabe, C.W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This fail-safe ion chamber system is designed to be part of the personnel safety system (PSS) for the Los Alamos neutron Scattering Center (LANSCE) at the Los Alamos National Laboratory. Its job is to protect the occupants of the experimental areas from large radiation doses caused by errant beam conditions during beam transport from the Proton Storage Ring (PSR) to the LANSCE neutron spallation target. Due to limited shielding between the beam transport line and the experimental area only if the beam losses in the transport line are very low. The worst case beam spill scenario is calculated to result in a personnel exposure of about 0.01 Gys/s (1 rad/s). Although the preferred solution is to increase the bulk shielding between the beam line and the experimental area, the physical dimensions of the site do not permit an adequate amount of shielding to be added. The solution adopted is a layered system of three types of highly reliable detector systems: a current limiter system located in the beam line, a neutron detector system located in the experimental areas, and an ion chamber system located on the walls of the beam line tunnels. The ion chamber system is capable of shutting off the beam in less than 0.5 s, resulting in a worst case personnel exposure of 0.005 Gys (0.5 rad). 4 figs.

31154 Pulse-power-induced oscillations of the REX (Relativistic Electron-Beam Experiment) electron beam. Builta, L.A. (Los Alamos National Laboratory, NM (USA)); Carlson, R.L.; Kauppila, T.J.; Moir, D.C.; Ridlon, R.N.; Hughes, T.P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Relativistic Electron-Beam Experiment pulse power generator is used to produce a 4-MeV, 5-kA, 50-ns electron beam. The beam is produced by a planer velvet cathode. Multiple current rise times are used to examine pulse-power-induced beam oscillations. Diagnostics include a streak camera and high-speed electronic probes for monitoring current and voltage. Correlation between beam oscillations and TE/TM cylindrical cavity modes in the anode-cathode gap is examined. 2 refs., 9 figs.

31155 General analysis of beam position monitors. di Massa, G. (Univ. della Calabria (Italy)); Ruggiero, A.G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A large proportion of devices used to interact with charged-particle beams in accelerator or storage rings can be classified as pick-ups or kickers. These devices extract information about the particle motion or affect a change in the motion. One device used frequently as pick-up or kicker is made with two little plates with one or more terminations per plate. In this paper the structure with one termination per plate is examined. 3 figs.

31156 Beam characterization with video imaging systems at the ANL 50-MeV H^- beamline. Yule, T.J. (Argonne National Laboratory, IL (USA)); Bellinger, F.O.; Coleman, T.A.; Faber, M.M.; Fink, C.L.; Roche, C.T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Video imaging systems consisting of scintillators and charge-coupled device (CCD) cameras and in-beam CCD detectors are being used to characterize beams at the Argonne National Laboratory (ANL) 50-MeV H^- beam-line. The characterization technique consists of placing pinholes, slits, or wires in the beam and then viewing the resulting images or shadows on a down-stream scintillator or CCD. The images are digitally recorded using a frame

grabber. The images are stored in computer memory where they are analyzed to determine Twiss parameters and local beam divergence. Since many of these measurements involve low intensity beams and require good position resolution, studies have been performed on scintillators to obtain sensitivity and resolution data. Various scintillators, including Rarex, CsI, and CaF_2, have been evaluated. An in-beam CCD imager has also been tested. 5 refs., 4 figs.

31157 Wire scanner news from the CERN-SPS. Burns, A. (European Organization for Nuclear Research (CERN), Geneva (Switzerland)); Camas, J.; Amico, E.D.; Ferioli, G.; Kissler, K.H.; Mann, J.; Schmidt, R.; King, Q. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Wire scanners have been used successfully to measure the transverse beam profiles of proton and antiproton beams in the CERN-SPS for about one decade. More recent developments of the wire scanner system are reported here: (a) since electrons and positrons are accelerated in the SPS for LEP injection the detection system of a wire scanner was modified and the instrument was used to measured lepton bunch profiles. (b) For the measurement of beam profiles of the high intensity proton beam in fixed target physics a limit was found for the beam intensity which the fibre can support without damage caused by heating. This allows the use of the wire scanners to measure the profiles at maximum beam energy and intensity without the risk of destroying the fibre. (c) With the development of high precision wirescanners for the SPS comes the need for a better data acquisition system. The new scanners will generate more data (up to 32K per scan) compared to the old wire scanners and will be driven from electronics residing in a VME system. Here the authors report about a prototype data acquisition system housed in a VME crate and connected to the operator consoles via the new (token ring) network. 5 refs., 5 figs., 1 tab.

31158 The measurement of Twiss parameters using segmented Faraday cups. Rosing, M. (Argonne National Laboratory, IL (USA)); Hummer, C.; Zolecki, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Segmented Faraday Cup (SFC) consists of 48 copper plates that are 1 mm × 75 mm × 10 mm. These plates are stacked against each other on the 75 mm × 10 mm face with a layer of kapton between them for electrical insulation. When the assembly is viewed in the direction of the incident beam, the beam sees 48 vertical electrodes that are 1 mm × 75 mm and 10 thick. The copper plates and the kapton are held together in an aluminum frame which is mounted on a rotating shaft. The charge collected by each electrode is stored on a capacitor. The voltage on each of these capacitors is sequentially presented to a buffer amplifier, and the profile of the beam can then be read out. Timing pulses are provided during the readout to trigger the analog to digital converter (ADC). Each time the ADC receives one of these timing pulses, it digitizes the voltage from the buffer amplifier. A computer then stores these data for documentation and further study, or the computer may use the data for on-line calculations. The SFCs were used to measure the emittance of the beam by using a scanning slit. The theory and the method for this measurement are presented in Section I. A description of the electronics is presented in Section II. A sample of a beam profile and the results of an emittance measurement are presented in Section III. 2 refs., 5 figs.

31159 RF phase measurement at PHERMEX using time-to-digital converters. Watson, S.A. (Los Alamos National Laboratory, NM (USA)); Jennings, G.R.; Moir, D.C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Recent advances in time-to-digital converters (TDCs) have made 50-MHz rf phase measurement possible without the use of double-balanced mixers. These advances allow zero crossing discriminators to be used in conjunction with fast CAMAC TDCs to make amplitude-independent phase measurements. This method uses a time interval proportional to the phase angle thus eliminating any of the calculations and calibration required with double-balanced mixers. 4 refs., 1 tab.

31160 Fitting measured emittance data. Meads, P.F. Jr. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Emittance measurements have been made at several points in the 50-MeV Neutral Particle Beam Test Stand of ANL. These measurements were made with segmented Faraday cups that measure the angular distribution after passing the beam through a movable slit. The measured distribution is very nonuniform, and thus the Twiss parameters for the best fit at a given emittance depend on the ellipse area. We here describe a program that optimizes the Twiss parameters and the ellipse center as a function of the emittance. This is done separately in the two lateral phase planes. The β and α parameters and the ellipse center are adjusted such that the total count contained within the ellipse is maximized. The optimization method is due to Powell and Brent; it does not require the evaluation of derivatives. Input data are read as a two-dimension array (displacement and angle). For cells containing the ellipse, the incremental count used is estimated by determining the intercepts of the ellipse in the two dimensions and approximating that portion of the curve by a straight line. Optional initial smoothing of the measured data is provided. This analysis method differs from that in the paper by Rosing, Hummer, and Zolecki (this conference) where they find a set of Twiss parameters, the center of the beam and emittance that fits an assumed distribution. 3 refs., 1 fig.

31161 A technique for improving the accuracy and dynamic range of beam position-detection equipment. Wells, F.D. (Los Alamos National Laboratory, NM (USA)); Jachim, S.P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Beam position detection equipment often employs circuits that convert amplitude-modulated position signals to phase modulation. These signals are limited to remove amplitude variations and phase detected to obtain analog position information. The phase-modulated signals are clipped by limiters that must be closely phase matched in pairs over the signal intensity range of interest. Accuracy and dynamic range are determined principally by the phase match between the limiters. When the time duration of the beam is a few microseconds or more, significant improvements can be obtained by down-converting the RF signals to an intermediate frequency near 10 MHz. Limiter circuits are available that can be closely matched in pairs at 10 MHz over a 60-dB signal amplitude range. For example, the peak phase deviation measured among 30 matched pairs was $<0.4°$, corresponding to a phase tracking error of <0.1 dB. This exceptional matching enabled beam position measurements over a 50-dB dynamic range of signal intensity. A description of the detection technique and the limiter is given by this paper. 6 refs., 6 figs.

31162 On-line monitoring of dispersion functions and transfer matrices at the SLC. Emma, P. (Stanford Univ., CA (USA)); Fieguth, T.H.; Lohse, T.; Burchat, P.R.; Panvini, R.S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The symmetries of the chromatic correction sections in the SLC Final Focus System allow a high-resolution determination of pulse-to-pulse energy fluctuations by exploiting the information from

beam position monitors (BPMs) in regions of large dispersion. By correlating this signal with other BPMs, one can infer the dispersion function as well as spatial components of transfer matrices anywhere in the arcs and the Final Focus System with out interrupting normal machine operation. The authors present results from data recorded during either periods of stable operation or periods when the linac energy was intentionally varied. 6 refs., 7 figs.

31163 A beam position monitor for low current DC beams. Adderley, P. (Continuous Electron Beam Accelerator Facility (CEBAF), Newport News, VA (USA)); Barry, W.; Heefner, J.; Kloeppel, P.; Rossmanith, R.; Wise, M.; Jachim, S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The 4 GeV recirculating linac, CEBAF, is presently under construction and will produce a CW beam with average current between .1 and 200 μA. In order to measure beam position, the beam current will be amplitude modulated at a frequency of 10 MHz. The modulation is detected by an inductive loop type monitor with electronics sensitive only to the modulation frequency. The first tests with beam from the CEBAF injector indicate that beam position can be measured with an accuracy of .1 mm at a modulated beam current of 1 μA. 1 ref., 6 figs., 1 tab.

31164 Upgrading the CERN PS booster to 1 GeV for improved antiproton production. Cappi, R. (CERN, Geneva (Switzerland)); Garoby, R.; Rasmussen, N.; Riunaud, J.P.; Schindl, K.; Schoenauer, H. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

For efficient antiproton production, a maximum number of protons has to be concentrated within one quarter of the CERN Proton Synchrotron (PS) ring before sending the beam to the production target. Now, with the Antiproton Collector (AC) added to the Antiproton Accumulator (AA), the bunch length has to be shorter (about 20 ns) than before in order to allow bunch rotation in the AC. Whilst a more ambitious scheme providing such a beam is being implemented, a funneling method-where beams of two rings out of the four-ring Proton Synchrotron Booster (PSB) are recombined in pairs by means of an RF dipole that permits longitudinal interleaving of successive bunches-is in operation since the start-up of the AC. Preliminary experiments had shown that the PS space-charge limit had to be overcome in order to make the scheme feasible. Indeed, after raising the PSB output energy from 815 MeV to 1 GeV - with a rather modest effort - beams of $> 10^{13}$ protons squeezed into one quarter of the PS ring were achieved. As a spin-off of this development, a new record proton beam for fixed-target physics was accelerated in the Super Proton Synchrotron (SPS), while beam losses in the PSB-PS line were reduced. Here we deal with this upgrading, give a short summary of past, present, and future $\bar{p}$ production beams in CERN, and discuss some trickier beam dynamics aspects of the very particular one obtained by funneling. 7 refs., 7 figs., 1 tab.

31165 H^0 injection for the JHP compressor/stretcher ring. Yamane, I. (KEK, National Laboratory for High Energy Physics, Ibaraki-ken (Japan)); Kitagawa, K. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An H^0 injection system is proposed for the JHP compressor/stretcher ring (which had been formerly called as the JHF I-A ring). It is based on the two step stripping using a stripper magnet and a stripping foil. The H^0 beam is formed to match the ring optics at the stripping foil. In order to reduce the foil hitting probability to as low as 10%, not only a corner foil but also a phase space painting by varying the bump orbit are proposed. 11 refs., 7 figs.

31166 Data acquisition, control, and analysis for the Argonne Advanced Accelerator test facility (AATF). Schoessow, P. (Argonne National Laboratory, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The AATF has been used to study wakefield acceleration and focusing in plasmas and RF structures. A PC-based system is described which incorporates the functions of beamline control and acquisition, storage, and preliminary analysis of video images from luminescent screen beam diagnostics. General features of the offline analysis of wakefield data are also discussed. 4 refs., 3 figs.

31167 Object-oriented communications. Chapman, L.J. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

OOC is a high-level communications protocol based on the object-oriented paradigm. OOC's syntax, semantics, and pragmatics balance simplicity and expressivity for controls environments. While natural languages are too complex, computer protocols are often insufficiently expressive. An object-oriented communications philosophy provides a base for building the necessary high-level communications primitives like I don't understand and the current value of X is K. OOC is sufficiently flexible to express data acquisition, control requests, alarm messages, and error messages in a straightforward generic way. It can be used in networks, for intertask communication, and even for intra-task communication.

31168 Progress on a new control system for the Bevalac. Lewis, S.A. (Lawrence Berkeley Laboratory, CA (USA)); Biocca, A.K.; Dwinell, R.D.; Guggemos, J.R.; Shalz, L.L.; Brown, W.L.; Boyle, G.S.; Fowler, K.; Meaney, D.L. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Progress is reported on replacing a heterogeneous triplex of outdated control systems with a single system. Prominent use of hardware and software standards is made to allow for an incremental upgrade, for best use of rapidly changing technology, for off-the-shelf computer and I/O hardware, and for several commercial software packages. A non-hierarchical architecture with a distributed run-time database is employed. 9 refs., 4 figs.

31169 Networking remote instrumentation for the Advanced Light Source. Chin, M. (Univ. of California, Berkeley (USA)); Hinkson, J.; Magyary, S. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Advanced Light Source (ALS) control system instrumentation includes high data rate instruments such as digital oscilloscopes, sending 5000-10,000 bytes/s, and low data rate instruments such as network analyzers, digital multimeters and frequency counters sending < 1000 bytes/s. These instruments monitor signals in racks at distances up to 80m from the control room. Remote instrumentation will reduce cabling to the control room and possibly provide for better signal measurement. Inclusion of remote instrumentation data into the machine database will provide flexible access, display, and control from multiple operator workstations. Currently available instrumentation and computers have sufficient performance to provide realtime response in a network configuration. 1 ref., 4 figs.

31170 LNLS [Laboratorio Nacional de Luz Sincrotron] control system conceptual design. Franco, J.G.R.S. (LNLS,

Campinas (Brazil)); Furquim, S.; Monteiro, O.; Rodrigues, A.R.; Scorzato, C.R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The final goal of the LNLS (Laboratorio Nacional de Luz Sincrotron) is to operate two storage rings (VUV and x-rays) for the production of synchrotron light. These two rings will be injected by a 100 MeV LINAC and a synchrotron booster up to 2 GeV. A study of the control system for the LNLS accelerators showed that most of it can be done by 8-bit microprocessors at the equipment level. In order to reduce costs in the initial phase while maintaining the compatibility with 16 and 32-bit microprocessors in the future, the option was made in favor of the VME bus structure, with a specially designed local bus. Only few types of circuit boards are necessary for assembling the system at this level. The other two levels of the system use commercially available computers. 2 refs., 2 figs.

31171 VME bus performance in multiprocessor systems. Mayer, G. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Voy, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The complexity of future control systems will require large amounts of processing power in each individual subsystem. This can be achieved by using a higher performance processor or by using multiple processors within a single system. Multiple processors on a single bus may saturate the bus so as to reduce the expected performance gain. In order to determine an empirical limit for the number of processors that a VME bus can support, experiments were conducted to find the point at which VME system output was not increased by the addition of more processors. This paper details the results of those tests. 2 refs., 8 figs.

31172 A local area computer for data acquisition and control. Russ, T. (MIT Bates Linear Accelerator Center, Middleton, MA (USA)); Radouch, Z.; Sibley, C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A low cost control and data acquisition computer system was developed to be used as an element in distributed architecture control systems. It can be viewed as a low cost replacement for the CAMAC crate and its associated computer. This Local Area Computer (LAC) is based on the STD bus backplane, a low end industrial standard. Currently, it runs on a 8088 based processor card. Communication with other computers on the system is achieved through a specially designed SCSI-Ethernet controller, which can be programmed to allow sending of data only during a specified time slot. This mechanism avoids delays on the network due to collisions, and enables the LAC to dump it entire database at regular intervals for retrieval by one or several hosts. Software - written in C and running under the VRTX real time executive-mimics the easy access to the hardware typical of CAMAC modules, allowing interfacing to control system software developed at other laboratories. Most of the LAC components are off the shelf items. However, some peripherals specific to accelerators, such as high stability voltage references and change ADCs, were developed in house. 4 refs., 3 figs., 1 tab.

31173 A digital control system for accelerator operator - host computer interface. Tilbrook, I. (Argonne National Laboratory, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A design for a digital control system for use by an accelerator operator is presented. The system is designed to interface the operator to the host control computer. This is done using panel mount rotary optical shaft encoders. Peripheral hardware processes the shaft encoder signals and allows the operator control over signal parameters such as rate-of-change, etc. A design for a remote terminal for data input and control commands, which is in communication with the host via RS-232, is also presented. The overall design maximizes ease-of-use by the operator while flexibility and expandability are increased over the levels afforded by current systems in use at the Argonne Tandem-Linear Accelerator System (ATLAS). Alternative applications and future improvements are also discussed. 8 refs., 3 figs.

31174 The RTC - a software support system for the control of the CERN SPS. Herr, W. (CERN, Geneva (Switzerland)); Lauckner, R.; Morpurga, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The RTC (Run Time Coordinator) is a software support system designed for the SPS control system to provide a runtime environment for application software. It coordinates the execution of individual programs or processes and supervises the process control, i.e. process synchronization, inter process communication, data transfer and operator I/O. This supervision includes the control of processes distributed on a UNIX based network. A standard language independent data interface is part of the system. The system includes tools for data presentation, error logging and contention resolution. This strategy of separating system dependent features from the body of the application programs leads to high flexibility and simplifies the software development. The basic philosophy of the RTC is discussed and its implementation is described. 7 refs.

31175 Vax Q-Bus to CAMAC systems crate interface for long CAMAC branches. Sarkar, S. (TRIUMF, Vancouver, B.C. (Canada)); Roberts, W.; Mouat, M.; Miles, Y.; Bennett, P.; Purvis, A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The TRIUMF Central Control System (CCS) was to be upgraded to use Q-Bus based Vaxes. The CCS consists of multiple computers interfaced to a CAMAC Executive Crate with long parallel branches containing multiple pairs of Differential Branch Extenders (DBE). The Creative Electronics System SCI 2280 systems crate interface used for the Q-Bus Vax requires the CAMAC operation to complete synchronously with the Q-Bus cycle in less than the Q-bus timeout period. This translates to a maximum branch length of about 150 meters containing 3 pairs of DBEs, which was not adequate. A Q-Bus to SCI 2280 interface was built to allow CAMAC cycles to be decoupled, when desired, from the Q-Bus cycles. When cycles are decoupled, completion of the CAMAC part can be ascertained by testing flags in the interface. A description of the interface design and its operation as well as the results of tests using a VAS 3500 will be given. 2 refs., 2 figs.

31176 The Ground Test Accelerator control system database: Configuration, run-time operation, and access. Dalesio, L.R. (Los Alamos National Laboratory, NM (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A database is used to implement the interface between the control system and the accelerator and to provide flexibility in configuring the I/O. This flexibility is necessary to allow the control system to keep pace with the changing requirements that are inherent in an experimental environmental environment. This is not achieved without cost. Problems often associated with using databases are painful data entry, poor performance, and embedded

knowledge of the database structure in code throughout the control system. This report describes how the database configuration, access, conversion, and execution in the Ground Test Accelerator (GTA) Control System overcome these problems. 2 figs.

31177 Design and implementation of a VMEbus system service card. Beechy, D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Mayer, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The System Services Card (SSC) is a multi-function VMEbus module designed to provide useful debugging features for code development and system services that are needed in most configuration. The card has the following features: 80 character by 24 line composite video signal (6845 CRT controller), Two serial I/O ports (68661 and 68901), Time of day and date with alarm clock (Dallas Semiconductor DS1286), Slot 1 System Controller (Mizar VME 1000), Four 8 bit timers (68901), System reset watchdog timer, Five front panel 5X7 dot matrix displays, Software readable up/down counter with front panel control, Front panel LED display with test points (32 bits), Front panel DIP switch (8 bits), Front panel push button bit set with interrupts (2 bits), Circuit board DIP switches - software readable (32 bits), General Purpose I/O (8 bits), Front panel system reset button, VMEbus interrupts from on-board devices, Eight channel interrupt generator for inter-processor communications, Audio alarm.

31178 VME-computer network (MAP) for the KEK proton synchrotron. Katoh, T. (KEK, National Lab. for High Energy Physics, Ibaraki-ken (Japan)); Nakagawa, H.; Ishii, K.; Kadokura, E.; Nigorikawa, K.; Akiyama, A.; Hirano, S.; Nakamura, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A VME-computer based system is used for controlling KEK proton synchrotron to replace old minicomputer based system. More than 20 node computers are connected with each other through a broadband token-bus network called MAP (Manufacturing Automation Protocol). The nodes are categorized into four types; a network management node (NM), a software development node (SW), operator's console nodes (OP's) and equipment control nodes (HW) that control accelerator equipment. System and application programs of any node except the SW and the NM are down-loaded from the NM and/or the SW. The MAP version 2.1 with File Transfer Access and Management (FTAM) and Common Application Service Element (CASE) is supported at present. A performance test of the network has been done and the results are reported here. 3 refs., 5 figs.

31179 MOPS - a data structure management system for the LEP/SPS control system. Herr, W. (CERN, Geneva (Switzerland)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The MOPS data structure management system has been developed for the LEP/SPS control system and is designed to support the programmers in organizing their data in a structured fashion. MOPS data structures can be accessed from FORTRAN 77 as well as from C programs and therefore allow the easy exchange of data between programs written in different languages. The data structure contains a full description of all data elements and their logical relations and simplifies the transfer across networks with different computer systems and data representations. A description of the data structure and the basic philosophy are presented. 5 refs.

31180 Stanford Linear Collider history data facility. Johnson, R. (Stanford Univ., CA (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

To effectively maintain the operation of the Stanford Linear Collider the variation over time of control system device parameters and feedback loops must be known. Device status must reflect unwanted variations as well as current states. This paper discusses the software facility which provides the collection and display of history data, and the determination of a behavioral status. The facility's operation, internal design, and user interface are described. 5 figs.

31181 Performance and modification of the MEA R.F. drive system. Kroes, F.B. (NIKHEF, Amsterdam (Netherlands)); Sluyk, T.G.B.W.; Heutenik, B. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The twelve modulator-klystron units serving the 500 MeV linear electron accelerator (MEA) will be modified to convert the accelerator into a 900 MeV, 0.2% d.f. injector for the pulse stretcher project, presently under construction. The new klystrons needed for this purpose have to be provided with higher input R.F. peak power, which implies modification of the present R.F. drive system. This modification also involves the inclusion of fast R.F. PIN diode switches in the R.F. drive system of each klystron to enable spreading of the R.F. timing of the twelve stations. This is the pulse stretcher - to suppress the transient beam loading effect-Design consideration for the modification of the MEA R.F. drive system and initial tests will be presented. 6 refs., 6 figs., 5 tabs.

31182 Status: Large-scale subatmospheric cryogenic systems. Peterson, T. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the late 1960's and early 1970's an interest in testing and operating RF cavities at 1.8K motivated the development and construction of four large (300 Watt) 1.8K refrigeration systems. in the past decade, development of successful superconducting RF cavities and interest in obtaining higher magnetic fields with the improved Niobium-Titanium superconductors has once again created interest in large-scale 1.8K refrigeration systems. The L'Air Liquide plant for Tore Supra is a recently commissioned 300 Watt 1.8K system which incorporates new technology, cold compressors, to obtain the low vapor pressure for low temperature cooling. CEBAF proposes to use cold compressors to obtain 5KW at 2.0K. Magnetic refrigerators of 10 Watt capacity or higher at 1.8K are now being developed. The state of the art of large-scale refrigeration in the range under 4K will be reviewed. 28 refs., 4 figs., 7 tabs.

31183 Measurement of the magnetic field coefficients of particle accelerator magnets. Herrera, J. (Brookhaven National Laboratory, Upton, NY (USA)); Ganetis, G.; Hogue, R.; Rogers, E.; Wanderer, P.; Willen, E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An important aspect in the development of magnets to be used in particle accelerators is the measurement of the magnetic field in the beam aperture. In general it is necessary to measure the harmonic multipoles in the dipole, quadrupole, and sextupole magnets for a series of stationary currents (plateaus). This is the case for the Superconducting Super Collider (SSC) which will be ramped to high field over a long period (~ 1000 sec.) and then remain on the flat top for the duration of the particle collision phase. In contrast to this mode of operation, the booster ring being constructed for the Brookhaven AGS, will have a fast ramp rate of approximately 10

Hz. The multipole fields for these Booster magnets must therefore be determined on the ramp. In this way the effect of eddy currents will be taken into account. The measurement system which the authors will describe in this paper is an outgrowth of that used for the SSC dipoles. It has the capability of measuring the field multipoles on both a plateau or during a fast ramp. In addition, the same basic coil assembly is used to obtain the magnetic multipoles in dipole, quadrupole, and sextupole magnets. 2 refs., 3 figs., 1 tab.

31184 Magnet design studies for the European Light Ion Medical Accelerator. Mandrillon, P. (Centre Antoine Lacassagne, Nice (France)); Ostojic, R.; Ryckewaert, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the frame of the European Light Ion Medical Accelerator project, which calls for the acceleration of a 400 MeV/n ^{16}O beam in a hospital based facility, a study of the superconducting coil and sector magnets for the separated sector cyclotron has advanced. Several approaches to the 3D analysis of the magnetic field in a complicated structure have been employed, and attention is drawn to certain general properties of available methods. Details of the coil and iron design are presented, implications of beam dynamics considered, and the optimal shape of the pole sectors derived. 3 refs., 5 figs., 1 tab.

31185 Training of LBL-SSC model dipole magnets at 1.8 K. Gilbert, W.S.; Althaus, R.; Benjegerdes, R.; Caspi, S.; Peters, C.; Rechen, J.; Royet, J.; Scanlan, R.; Taylor, C.; Wandesforde, A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors present the 1.8K training behavior of SSC Magnets, several of which have reached a peak current of 9400 A; a central field of 9 Tesla. For the SSC Project, more than 30 one meter long dipole magnets have been built and tested. The test results for the 4.3K operation have been presented previously. Magnet operation, primarily reaching design field without premature training, is expected to be superior in superfluid helium at 1.8K as compared with helium I at 4.3K. Not only is the critical current increased at the lower temperature, but the heat transfer is much improved. LBL has had an operating helium II facility for nine years and the authors standard test sequence has been to check for training in helium I at 4.3K and then cool the system down to 1.8K and train the magnet to its new, high limit. Because the mechanical forces are much greater at the higher currents and fields achieved at the lower temperature, information has been obtained on the adequacy of the mechanical design. Even for those magnets in which training quenches occurred in the inner layer at 4.3K, many of the quenches at 1.8K occurred in the outer layer. 10 refs., 8 figs.

31186 Long-term test of a LEP prototype superconducting cavity in the CERN SPS. Boussard, D. (CERN, Geneva (Switzerland)); Cavallari, G.; Kindermann, H.P.; Passardi, G.; Stierlin, R.; Tueckmantel, J.; Weingarten, W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

After the commissioning of the LEP e^+e^- collider at CERN, its energy will be upgraded by adding superconducting (s.c.) r.f. cavities. Obviously, there is a great incentive to test a prototype s.c. LEP cavity in one of CERN's existing accelerators, before a production in series of a large number of cavities (256) be launched. Such a test should prove the validity and the long-term reliability of the design in a real accelerator environment. The SPS proton accelerator/proton-antiproton collider/LEP injector was chosen for the implementation of the cavity, being at present CERN's largest accelerator. As a result the whole experiment (comprising Cavity, cryostat, refrigerator and r.f. system, installed in the tunnel about 60 m below ground) had to be remotely controlled from the accelerator surface buildings, in order not to interfere with the physics program. As long as a refrigerator was not yet delivered (during the first phase of the experiment) we used a 100 m long flexible He transfer line for cooldown with dewars located at the surface. Later on a cold box was installed 6 m off the cryostat, the compressor and control unit being placed in a surface building. For the operation of the SPS as a proton accelerator at high intensity ($I_{d.c.}$ = 0.2 A), on magnetic cycles interleaved with cycles for lepton acceleration, the impedance of the s.c. cavity had to be reduced by several orders of magnitude. This was achieved by damping the cavity's fundamental passband mode impedances by an r.f. feedback including the tetrode power amplifier driving the cavity [1,2]. 10 refs., 5 figs.

31187 The CERN antiproton accumulator clearing system with ion current measurements as a residual neutralization diagnostic. Pedersen, F. (CERN, Geneva (Switzerland)); Poncet, A.; Soby, L. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

During the first 5 years of operation of the Antiproton Accumulator (AA) a whole set of limiting phenomena induced by the residual neutralization by ions were observed and identified: charged dust particles causing beam blow-up, dipolar and quadrupolar coherent instabilities and excitation of high-order non-linear resonances. During the construction of the Antiproton Collector (ACOL) the AA was upgraded to cope with the higher antiproton flux, and new clearing electrodes were added together with individual computer control of applied clearing voltage and acquisition and recording of clearing currents. A general description of the new AA ion clearing system is given, together with a first account of the clearing currents behavior. 9 refs., 7 figs.

31188 Scaling laws for aberrations in magnetic quadrupole lens systems. Moses, R.W. (Los Alamos National Laboratory, Los Alamos, (NM)); Heighway, E.A.; Christian, R.S.; Dragt, A.J. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

A comparison has been made of the third-order (spherical) aberrations in magnetic particle beam transport systems. An analytical description of the aberrations is presented and this is compared with the results of high order numerical integration. The dependence of the aberration strength on the system geometry and focal length is given and a comparison of doublet and triplet systems made. The reduction of the aberrations in both doublet and triplet systems using embedded magnetic octupole lenses is also discussed and analytical predictions are given.

31189 Progress report on the LEP pre-injector. Battisti, S.; Bossart, R.; Delahaye, J.P.; Huebner, K.; Garoby, R.; Kugler, H.; Krusche, A.; Madsen, J.H.B.; Potier, J.P.; Riche, A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The LEP Pre-injector (LPI) provided very reliably positrons and electrons at 500 MeV for the LEP injector chain during the first LEP injection tests. Later, experiments were performed with the LEP Injector Linacs (LIL) to verify the influence of various parameters on the positron current and on the conversion efficiency. The authors also report experiments done with the Electron-Positron Accumulation ring (EPA) operating at 500 MeV concerning trapping, accumulation, and equilibrium beam parameters. Cutting of the 8 bunches by a thin electrostatic septum to produce two batches of 8 bunches was successfully tested. First runs with e^+ and e^- at 600 MeV showed the LPI behaves also at this energy as expected. 11 refs., 5 figs.

31190 Improvements in bunch coalescing in the Fermilab Main Ring. Martin, P.S. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Meisner, K.G.; Wildman, D.W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper discusses the improvements in the performance of the bunch coalescing operation in the Fermilab Main Ring which have resulted in increased efficiency and the capability to produce bunches containing more than 10^{11} protons. The Main Ring can now produce intense coalesced bunches, although the efficiency decreases as the intensity is pushed up, apparently due to beam-loading effects. This inefficiency is made acceptable by using the Tevetron superdamper to eliminate unwanted beam. Bunches of twice the design intensity can be achieved, with further improvements possible. Studies are underway to better understand the beam-loading problems and to develop cures for their adverse effects. 3 refs., 3 figs.

31191 Performance of Fermilab Main Ring during the 1988-89 Tevatron collider operation. Martin, P.S. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Fermilab Main Ring serves as injector for the Tevatron at 150 GeV/c and as a source of 120 GeV/c protons for antiproton production. This paper discusses the Main Ring performance–intensity, reliability, and efficiency–during the present Collider run. Also discussed are questions related to emittance and emittance growth, both transverse and longitudinal, and the impact of Main Ring losses on the Collider experiments. 4 refs., 3 figs.

31192 Design and commissioning of the DO vertical nondispersive overpass in the Fermilab Main Ring. Trbojevic, D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Gerig, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A new vertical overpass in the Fermilab Main Ring around a future DO proton-antiproton collision detector was designed and built to raise the initial luminosity for collider physics. The new overpass provides a better dispersion match between the Main Ring and the Tevatron, and in the Main Ring substantially lowers the vertical beam size arising from momentum spread. This has also improved the overall efficiency and beam intensity of the Main Ring. Vertical dispersion was measured before and after completion of the new overpass. A high degree of correspondence was obtained between the predicted and measured values of vertical dispersion around the whole Main Ring. 4 refs., 7 figs.

31193 Recent commissioning experience on the SLC arcs. Toge, N.; Bambade, P.; Barklow, T.; Brown, K.L.; Bulos, F.; Burke, D.L.; Fieguth, T.; Haiessinski, J.; Hutton, A.; Jung, C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Arc transport line, which brings high-energy, high-intensity electron and positron bunches from the SLAC linac to the Stanford Linear Collider final focus section, has been in operation for the past few years. In this paper, the authors will review the techniques developed for the optical tune-up and diagnostics, recent performance, and on-going improvement programs. 13 refs., 4 figs., 1 tab.

31194 The performance of the SPS as LEP injector. Cornelis, K. (CERN, Geneva (Switzerland)); Schmidt, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The injection of positrons into the first octant of LEP during the LEP injection tests in 1988 required the SPS being operational as an injector for LEP. Positrons were accelerated in the SPS from an energy of 3.5 GeV to about 18 GeV and extracted into LEP during the test which lasted one week. This test as well as the further commissioning of the SPS with leptons could be made without any perturbation to the physics program. The leptons were accelerated in three cycles, interleaved in between the proton cycles and 4 bunches of positrons or electrons were accelerated on each of them. Bunches with intensities exceeding the design value of 0.8×10^{10} were accelerated. Following preliminary studies countermeasures against various collective effects allowed the acceleration of up to 2.6×10^{10} particles per bunch. The required momentum for LEP injection of 20 GeV for next year could also be achieved. 11 refs., 2 figs., 2 tabs.

31195 Automatic steering of x-ray beams from NSLS insertion devices using closed orbit feedback. Nawrocky, R.J. (Brookhaven National Laboratory, Upton, NY (USA)); Galayda, J.; Klein, J.D.; Singh, O.; Yu, L.H. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

By the middle of this year (1989), there will be five insertion devices installed in the NSLS X-ray electron storage ring. X-ray beams from these devices will be stabilized by local automatic steering systems to reduce beam motion at the end of the beamline. Both the position of the source and the direction of the radiation will be controlled using beam position feedback to the closed orbit. Another system will be installed to stabilize the electron orbit for the LEGS Compton backscattering experiment. Each feedback system will employ at least one X-ray beam position detector; some will also utilize rf electron beam position monitors. Analog hardware with a digital interface has been designed and will be installed in the near future. A totally digital realization of the feedback controller is under consideration. 6 refs., 6 figs.

31196 Detuning of the NSLS UV RF cavity to compensate for 1 ampere of stored beam. Thomas, M.; D'Alsace, R.; Ackerman, H.; Aspenleiter, J.; Broome, W.; Buda, S.; Fauchet, A.M.; Keane, J.; Mortazavi, P.; Ramirez, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The NSLS VUV ring is an electron storage ring dedicated to synchrotron radiation production and normally operates at 745 MeV. A single 52.887 MHz radio frequency cavity is used to compensate for the 14.7 kW of synchrotron radiation power per ampere of stored beam. Beam was first stored at the end of 1981, and the design current of 1 ampere was achieved in June 1986. The maximum stored beam was 1.2 amperes. A mechanically driven loop tuner in addition to water temperature variation is used to compensate for the reactive detuning of the 52.8 MHz RF accelerating cavity at a 1 ampere circulating current. This combination avoids the higher order resonances that occur with a single mechanical tune. System description and operating results will be detailed. 1 ref., 3 figs.

31197 Microprocessor control for the CEBAF RF control module. Ashkenazi, I. (Continuous Electron Accelerator Facility (CEBAF), Newport News, VA (USA)); Lahti, G.E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The CEBAF RF system is controlled by an array of local control computers set in a network and supervised by a central RF system supervisory computer. Each local computer, geographically located near a cluster of 32 klystrons in one service building above the accelerator tunnel, controls the parameters of these klystrons. The RF Control Module constitutes the control link between the local computer and the individual klystron and RF chain. The communication between the RF Module and the local computer is achieved through CAMAC. 2 figs.

31198 **Fast energy spectrum and transverse beam profile monitoring and feedback systems for the SLC linac.** Soderstrom, E.J. (California Institute of Technology, Pasadena (USA)); Abrams, G.S.; Weinstein, A.J.; Brown, R.L.; Gromme, T.E.; Jacobsen, R.G.; Seeman, J.T.; Zicker, J.E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Fast energy spectrum and transverse beam profile monitoring systems have been tested at the SLC. The signals for each system are derived from digitizations of images on phosphor screens. Individual beam bunch images are digitized in the case of the transverse profile system and synchrotron radiation images produced by wiggler magnets for the energy spectrum. Measurements are taken at two-second intervals. Feedback elements have been installed for future use and consist of RF phase shifters to control energy spectrum and dipole correctors to control the beam launch into the linac affecting the transverse beam profile. Details of these systems, including hardware, timing, data acquisition, data reduction, measurement accuracy, and operational experience will be presented. 9 figs.

31199 **Operational results of the BEAR flight RF system.** Lynch, M.T. (Los Alamos National Laboratory, NM (USA)); Devenport, J.C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Beam Experiment Aboard a Rocket (BEAR) flight rf control system has been completely designed and has been operated as a part of the flight accelerator system in the actual flight configuration. The accelerator has been vertically integrated onto the flight support structure (space frame) and has been operated in this configuration in preparation for the actual flight which is scheduled for late Spring, 1989. The rf control system consists of redundant voltage controlled oscillators, redundant amplitude controllers which maintain the proper fields in the RFQ, a frequency controller to maintain operation at the resonant frequency of the RFQ, and the necessary system monitors and the interfaces required for the amplifiers, onboard system controller, and telemetry. The rf controller had to meet the electrical and environmental requirements while staying with its weight limit. This paper describes the final design of the rf controller and results from operation of the controller in its final flight configuration. 4 refs., 6 figs., 1 tab.

31200 **Beam loading and cavity compensation for the Ground Test Accelerator.** Jachim, S.P. (Los Alamos National Laboratory, NM (USA)); Natter, E.F. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Ground Test Accelerator (GTA) will be heavily beam-loaded H^- linac with tight tolerances on accelerating field parameters. The methods used in modeling the effects of beam loading in this machine are described. The response of the cavity to both beam and radio-frequency (RF) drive stimulus is derived, including the effects of cavity detuning. This derivation is not restricted to a small-signal approximation. An analytical method for synthesizing a predistortion network that decouples the amplitude and phase responses of the cavity is also outline. Simulation of performance, including beam loading, is achieved through use of a control system analysis software package. A straightforward method is presented for extrapolating this work to model large coupled structures with closely spaced parasitic modes. Results to date have enabled the RF control system designs for GTA to be optimized and have given insight into their operation. 6 refs., 10 figs.

31201 **Amplitude and phase regulation of the RF separator.** Miszczak, J. (Univ. of Warsaw (Poland)); Burge, R.; Enegren, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The RF separator at TRIUMF has the cavity located 20 m from the power amplifier. This system is controlled by analog regulators with programmable loop parameters. The controller hardware is modular and can easily be adapted to other RF systems at TRIUMF. 4 refs., 4 figs.

31202 **An active feedback system to control synchrotron oscillations in the SLC Damping Rings.** Corredoura, P.L. (Stanford Univ., CA (USA)); Pellegrin, J.L.; Schwarz, H.D.; Sheppard, J.C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Initially the SLC Damping Rings accomplished Robinson instability by operating the RF accelerating cavities slightly detuned. In order to be able to run the cavities tuned and achieve damping for Robinson instability and synchrotron oscillations at injection an active feedback system has been developed. This paper describes the theoretical basis for the feedback system and the development of the hardware. Extensive measurements of the loop response including stored beam were performed. Overall performance of the system is also reported. 3 refs., 7 figs.

31203 **Longitudinal damping in the Tevatron collider.** Kerns, Q.A. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Jackson, G.; Kerns, C.R.; Miller, H.; Reid, J.; Siemann, R.; Wildman, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper describes the damper design for 6 proton on 6 pbar bunches in the Tevatron collider. Signal pickup, transient phase detection, derivative networks, and phase correction via the high-level rf are covered. Each rf station is controlled by a slow feedback loop. In addition, global feedback loops control each set of four cavities, one set for protons and one set for antiprotons. Operational experience with these systems is discussed. 7 refs., 9 figs.

31204 **RF control system development at CEBAF.** Simrock, S. (Continuous Electron Beam Accelerator Facility, Newport News, VA (USA)); Hovater, C.; Jones, S.; Fugitt, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The CEBAF RF control system uses a heterodyne scheme to convert the cavity frequency of 1497 MHz down to a more manageable IF frequency of 70 MHz. At this IF frequency all the signal processing is done. Because of the tight system requirements of $\pm 0.2^\circ$ phase stability and $\pm 2 \cdot 10^{-5}$ amplitude stability, CEBAF uses new technologies such as high speed analog circuits at 70 MHz. Major themes include components for signal processing in the control system and recent system performance tests. 6 refs., 6 figs.

31205 Numerically controlled oscillator for the Fermilab Booster. Crisp, J.L. (Fermi National Accelerator Laboratory, Batavia, IL (USA)); Ducar, R.J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In order to improve the stability of the Fermilab Booster low level rf system, a numerically controlled oscillator system is being constructed. Although the system has not been implemented to date, the design is outlined in this paper. The heart of the new system consists of a numerically synthesized frequency generator manufactured by the Sciteq Company. The 3 GHz/sec rate and 30 to 53 MHz range of the Booster frequency program required the design of a CAMAC based, fast-cycling (1 MHz), 65K x 32 bit, digital function generator. A 1 MHz digital adder and 12 bit analog to digital converter will be used to correct small program errors by phase locking the oscillator to the beam. 6 refs., 1 fig.

31206 Operational results of the raster scanning power supply system constructed at the Bevalac Biomedical Facility. Stover, G. (Univ. of California, Berkeley (USA)); Halliwell, J.; Nyman, M.; Dwinell, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A raster scanning power supply for controlling an 8.0 Teslameter relativistic heavy-ion beam at the Biomedical Facility has been recently completed and is undergoing electrical testing before on-line operation in 1989. The scanner system will provide tightly controlled beam uniformity and off-axis treatment profiles with large aspect ratios and unusual dimensions. This article will discuss original specification, agreement with measured results and special device performance (i.e. GTOs, FET actuator assembly, etc.). 5 refs., 5 figs.

31207 Advanced technology on the megawatt modulator for the ground test accelerator. Yasotornrat, H. (Los Alamos National Laboratory, NM (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper presents the new concept of accelerator technology developed by Los Alamos National Laboratory, AT-Division. The modulator is driven on-off by rf switching power supply to achieve 1-MW rf accelerator energy from the klystron and klystrode at 850 MHz. The advantages are listed below: (1) System cost saving up to 70%, (2) operating cost saving up to 60%, (3) weight reduced from 24 000 lbs. to 700 lbs, (4) size reduced from 512 to 12 cu. ft., and (5) efficiency improved from 75 to 97%. 2 figs.

31208 Magnet power supplies for the Advanced Light Source. Jackson, L.T. (Lawrence Berkeley Lab., CA (USA)); Lutz, I.C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Lawrence Berkeley Laboratory (LBL) is building an Advanced Light Source (ALS) to produce synchrotron radiation. An electron linear accelerator, and a booster synchrotron are used to accelerate the electron beam to 1.5 GeV to fill the storage ring. This paper describes the power supplies used for the magnets in the booster and the storage ring and the interface requirements of computer control and monitoring of the power supplies and magnet currents. 1 ref., 3 figs., 2 tabs.

31209 Tuning magnet power supply. Han, B.M. (Arizona State Univ., Tempe (USA)); Karady, G.G.; Thiessen, H.A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The particles in a Rapid Cycling Accelerator are accelerated by RF cavities, which are tuned by DC biased ferrite cores. The tuning is achieved by the regulation of bias current, which is produced by a power supply. The tuning magnet power supply utilizes a bridge circuit, supplied by a three phase rectifier. During the rise of the current, when the particles are accelerated, the current is controlled with precision by the bridge which operates as a power amplifier. During the fall of the current, the bridge operates in a switching mode and recovers the energy stored in the ferrites. The recovered energy is stored in a capacitor bank. The bridge circuit is built with 150 power transistors. The drive, protection and control circuit were designed and built from commercial component. The system will be used for a RF cavity experiment in Los Alamos and will serve as a prototype tuning power supply for future accelerators. 1 ref., 7 figs.

31210 Power supplies for the LNLS magnets. Lira, A.C. (Laboratorio Nacional de Luz Sincrotron, Campinas (Brazil)); Pomilio, J.A.; Wisnivesky, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Different kinds of magnets are required for the construction of the LNLS accelerators: Focusing coils for the klystrons. Spectrometer. Bending magnets and quadrupoles for transport lines. Bending magnets and quadrupoles for transport lines. Bending magnets quadrupoles and sextupoles for the booster and storage ring. In each case the power supply is designed to optimize performance and cost based on a rational use of available electronic devices. The authors discuss in this paper three different kinds of power supplies that have been developed at LNLS. (1) Low voltage, low current: up to 100 V, 50 A. These power supplies are used for the Linac magnets: focusing lenses, solenoids and transport line. (2) Low voltage, medium current: up to 50 V, 150 A. These include power supplies for klystron focusing coils. (3) Medium voltage, medium current: up to 300 V. 150 A to be used in the spectrometer, and bending magnets for the booster. In the following the authors discuss some general aspects of the structure and performance for each of these and describe the main results obtained. 1 ref., 4 figs.

31211 Distributed supervisory protection interlock system. Walz, H.V. (Stanford Univ., CA (USA)); Agostini, R.C.; Barker, L.; Cherkassky, R.; Constant, T.; Matheson, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Distributed Supervisory Protection Interlock System, DSPI, is under development at the Stanford Linear Accelerator Center for requirements in the areas of personnel protection, beam containment and equipment protection interlocks. The DSPI system, distributed over the application site, consists of segments with microprocessor-based controller and I/O modules, local area networks for communication, and a global supervisor computer. Segments are implemented with commercially available controller and I/O modules arranged in local interlock clusters, and associated software. Segments provide local interlock data acquisition, processing and control. Local area networks provide the communication backbone between segments and a global supervisor processor. The supervisor processor monitors the overall system, reports detail status and provides human interfaces. Details of an R&D test system, which will implement the requirements for personnel protection of 4 typical linear accelerator sectors, will be described. 4 refs., 2 figs.

31212 The Daresbury personnel safety system. Poole, D.E. (SERC Daresbury Laboratory, Warrington (England)); Ring, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3.

Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The personnel safety system designed for the SRS at Daresbury is a unified system covering the three accelerators of the source itself, the beamlines and the experimental stations. The system has also been applied to the experimental areas of the Nuclear Structure Facility, and is therefore established as a site standard. A dual guardline interlock module forms a building block for a relay based interlock system completely independent of the machine control system, although comprehensive monitoring of the system status via the control system computer is a feature. An outline of the design criteria adopted for the system is presented together with a more detailed description of the philosophy of the guardline logic and the way this is implemented in a standard modular form. The emphasis is on the design features of a modern microprocessor based variant of the original SRS system. Experience with the original system during build-up and operation of the SRS facility is described. 2 refs., 4 figs.

31213 Operational experience and techniques for controlled longitudinal phase space dilution in the AGS using a high harmonic cavity. Reece, R.K.; Ahrens, L.; Abola, A.; Brennan, J.M.; Cameron, P.; Ciardullo, D.; Dunbar, A.; Frey, W.; Goldman, M.A.; Kasha, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A fixed frequency 93 MHz harmonic cavity has been installed in the AGS ring. The primary purpose of this harmonic cavity is to increase (dilute) the longitudinal phase space area occupied by the beam by as much as a factor of four (to 4.0 eV-s) in a controlled, rapid manner while maintaining a smooth local density. This then will permit essentially lossless passage through transition energy (8.0 GeV) at intensities higher than previously achieved. Although the system controls permit as many as five dilutions per AGS cycle, only one is used at present. Effects of the various phase modulation programs, excitation period, and rf voltage programs on the dilution rate have been modeled. The parameters predicted to yield the best dilution have been implemented with satisfactory results. Further, a beginning has been made to explore the parameter space experimentally in order to determine the programs leading to the desired degree of dilution without loss of beam in the minimum time. 5 refs., 5 figs., 4 tabs.

31214 Reliability and lifetime predictions of SLC klystrons. Allen, M.A. (Stanford Univ., CA (USA)); Callin, R.S.; Fowkes, W.R.; Lee, T.G.; Vlieks, A.E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The energy upgrade of SLAC, with the first of the new 67 MW SLAC Linear Collider (SLC) klystrons, began over four years ago. Today there are over 200 of these klystrons in operation. As a result, there is a wealth of klystron performance and failure information that enables reasonable predictions to be made on life expectancy and reliability. Data from initial tests, follow-up tests and daily operation monitoring on the accelerator is stored for analysis. Presented here are life expectancy predictions with particular emphasis on cathode life. Also, based on this data, the authors will discuss some of the principal modes of failure. 3 refs., 2 figs., 1 tab.

31215 Circuit description of pulsed power systems. Rhee, M.J. (Univ. of Maryland, College Park (USA)); Fine, T.A. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The authors summarize the results of a comprehensive analysis of basic pulsed power systems. Two capacitive energy storage systems, lumped capacitor bank and LC generator, are described. Also described are counterparts in transmission line system, a voltage charged transmission line and Blumlein line. The inductive energy storage systems, which are duals of the capacitive energy storage systems, are described by the dual solutions obtained for the capacitive systems. 2 refs., 11 figs.

31216 The vertical alignment of the DO overpass in the Fermilab Main Ring. Moore, C.D. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In order to accommodate large detectors for pbar p physics at the Tevatron, the Main Ring has been modified to be non-planer in the sense of installing overpasses which create large vertical displacements of the beam orbit. The detailed placement of magnetic elements follows the screw geometry proposed by Tom Collins and implemented in a Fortran coded program, DSCREWF, by Sho Ohnuma. This program calculated the deviation of the new overpass from an assumed flat, perfectly aligned Main Ring. This paper describes the reality of working with the Main Ring as it was and fitting the new overpass into the overall pattern of the Main Ring. 4 refs., 6 figs., 1 tab.

31217 Magnetic properties of the ALS Booster synchrotron engineering model magnets. Keller, R. (Lawrence Berkeley Laboratory, CA (USA)); Green, M.I.; Hoyer, E.; Koo, Y.M.; Luchini, K.; Marks, S.; Milburn, J.; Nelson, D.H. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Advanced Light Source (ALS) at Lawrence Berkeley Laboratory is designed to be a third-generation electron storage ring producing high-brightness VUV and X-ray radiation from wriggler and undulator insertion devices. Engineering models of all lattice magnets that are to be installed in the storage ring and its booster synchrotron have been built and are being tested to verify their performance. This paper is concerned with the magnets that form the booster lattice: dipoles, quadrupoles, sextupoles, and corrector dipoles (steerers). After a brief outline of measurement techniques and equipment, the major design parameters of these magnets are listed. Measured effective lengths and multipole field errors are then given for each type. All engineering models meet the specifications, and tracking studies including the measured systematic field errors show acceptable performance of the booster synchrotron; hence the designs are qualified for production. 3 refs., 7 figs., 4 tabs.

31218 Design, fabrication, and calibration of curved integral coils for measuring transfer function, uniformity and effective length of LBL ALS Booster dipole magnets. Green, M.I. (Lawrence Berkeley Lab., CA (USA)); Nelson, D.; Marks, S.; Gee, B.; Wong, W.; Meneghetti, J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A matched pair of curved integral coils has been designed, fabricated and calibrated at Lawrence Berkeley Laboratory for measuring Advanced Light Source (ALS) Booster Dipole Magnets. Distinctive fabrication and calibration techniques are described. The use of multifilar magnet wire in fabricating integral search coils is described. Procedures used and results of AC and DC measurements of transfer function, effective length, and uniformity of the prototype booster dipole magnet are presented in companion papers. 8 refs., 3 figs., 1 tab.

31219 An improved phase-controlled system for superconducting low-velocity accelerating structures. Bogaty, J.M.

(Argonne National Laboratory, IL (USA)); Clifft, B.E.; Shepard, K.W.; Zinkann, G.P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Microphonic fluctuations in the RF eigenfrequency of supeconducting (SC) slow-wave structures must be compensated by a fast-tuning system in order to control the RF phase. The tuning system must handle a reactive power proportional to the product of the tuning range and the RF energy content of the resonant cavity. The accelerating field level of many of the SC cavities forming the ATLAS linac has been limited by the RF power capacity of the presently used PIN-diode based fast-tuner. A new system has been developed, utilizing PIN diodes operating immersed in liquid nitrogen, with the diodes controlled by a high-voltage VMOS FET driver. The system has operated at reactive power levels above 20 KVA, a factor of four increase over an earlier design. 7 refs., 2 figs.

31220 **Phasing tools for the klystrons at the SLC.** Jobe, R.K. (Stanford Univ., CA (USA)); Phinney, N.; Adolphsen, C. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Modern large accelerators require the RF sources to be correctly phased to control emittance growth, and to preserve the energy and energy spread of the beam. Computer-based tools have been developed to aid in the phasing of the klystron RF sources at the SLC. Changes in hardware can result in different phase values for maximum energy gain; the hunting for the sources of these changes continues. Results and operational experience are presented. 5 refs., 4 figs.

31221 **RF phase distribution systems at the SLC.** Jobe, R.K. (Stanford Univ., CA (USA)); Schwarz, H.D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Modern large linear accelerators require RF distribution systems with minimal phase drifts and errors. Through the use of existing RF coaxial waveguides, and additional installation of phase reference cables and monitoring equipment, stable RF distribution for the SLC has been achieved. This paper discusses the design and performance of SLAC systems, and some design considerations for future colliders. 6 refs., 4 figs.

31222 **Microprocessor based power supply control system.** Rumrill, R.S. (Alpha Scientific Electronics, Inc., Hayward, CA (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A microprocessor based control system is being developed which would not only service many of the power supplies own internal functions, but also incorporates an intelligent computer communication port. This will often eliminate the need to use a separate interface. Certain configuration variables are stored on EEPROM (Electrically Erasable Programmable Read Only Memory), which can be programmed using simple ASCII commands via the computer port. 11 refs., 1 fig.

31223 **Effects of irradiation on Hall probe sensitivity.** Kulke, B. (Lawrence Livermore National Laboratory, CA (USA)); Frye, R.; Penko, F. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Four Hall probes from two different manufactures were exposed to increasing amounts of radiation at the LLNL Advanced Test Accelerator and were compared periodically to an NMR Gaussmeter at magnetic field values of 2 to 8 kG. The radiation was primarily bremsstrahlung from a 45-MeV electron beam. The probes were mounted near a beam dump, along with LiF thermoluminescent detectors to keep track of the cumulative dose. The data show a threshold near 100 krad, beyond which point the probes tend to lose sensitivity and perform outside their nominal error limits. 3 refs., 8 figs., 1 tab.

31224 **Operational experience with the Fermilab Antiproton source.** Harms, E. Jr. (Fermi National Accelerator Laboratory, Batavia, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Fermilab Antiproton source began operation in 1085 and now routinely runs at or near design specifications. Experience with the source in its primary modes of operation is described. A summary of operating statistics, improvements, and sources of downtime is presented. 5 refs., 4 figs., 2 tabs.

31225 **A new system to trigger fast rise Thyristors.** Sakai, I. (National Laboratory for High Energy Physics, Ibaraki-ken (Japan)); Kawakubo, T.; Suetake, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Four bump magnets were installed in the KEK booster ring in order to shift the closed orbit toward the stripping foil during the H^- ion beam-injection period. The bump magnet power supplies are of the Pulse Forming Network type. Energy stored in the PFN is delivered to the magnet load via a series array of 32 thyristors. These thyristors must be turned on simultaneously. If there are any differences in the turn-on time, excessive high voltage is added to the thyristor which has the latest turn-on time. To solve this problem, a new trigger system was developed. Turn-on timing pulses are generated in a low-voltage circuit. Each timing pulse is adjusted independently with an accuracy of 0.1 μsec and converted to optical pulse. These optical pulses are transmitted to the high-voltage circuits through optical fibers. The phototransisters are exited and deliver the pulse current from the capacitor to the gate of thyristors, which are fired with an accuracy of 0.1 μsec. 1 ref., 6 figs., 2 tabs.

31226 **Relativistic multipactoring.** Gallagher, W.J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Increasingly, since multipactoring was first described by Philo Farnsworth in the 1930's, it has been the supposed defect in many microwave devices. It is thought to have occurred in proton linear accelerators (between drift tubes), klystron cavities, obstacle loaded waveguides and super-conducting cavities. In many such devices field strengths are often rather high so that the classical calculation is presumably not adequate. This report presents a relativistic calculation of the multipactoring condition for the two surfaces phenomenon. 4 refs.

31227 **A method of frequency following of the LINAC with power feedback.** Xi, De-Xun (Nanjing Univ. (China)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

There are three factors to influence the frequency stability of the magnetron which is the power source of the LINAC: the change of the modulating voltage, the slow change of the environment temperature and the unstable reflection from the accelerating tube with

the power feedback. The authors can use a decreasing Q circuit to stabilize the modulating voltage. The frequency shift caused by the change of the environment temperature can be decreased by a frequency stabilization system. The frequency change introduced by the unstable reflection can be decreased by an adaptive frequency following controller. When an adaptive control loop is added to the feedback loop of the frequency stabilization system, the adaptive frequency following will present. A digital controller which is a single chip microprocessor is used to perform a rapid frequency stabilization and a slow frequency following. The optimal frequency following is realized by maximizing the area of the superposition envelope at the entrance of the accelerating tube. In order to realize the rapid frequency stabilization, a high speed SCR system with three current converters in sequence is used to drive the stepping motor of the frequency stabilization system. 3 refs., 3 figs.

31228 RF bypass on the proton synchrotron vacuum chamber flanges. Cappi, R. (CERN, Geneva (Switzerland)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Small circuits, generally called RF-bypass, made with resistors and capacitors, have sometimes been connected across the isolated vacuum chamber flanges in circular accelerators. The reason why these circuits are installed, the design criteria and some technological aspects adopted in the last fifteen years at the CERN PS machine are described in the following chapters. 3 refs., 6 figs.

31229 New accelerator sections for the 2 GeV linac. Biller, E.Z. (Kharkov Institute of Physics and Technology (USSR)); Vishnynkov, V.A.; Dovbnya, A.N. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

New accelerating sections have been designed and constructed to increase the beam energy in the 2 GeV electron linac. This report describes the choice of the accelerating structure, the results of the computations and tests. The average accelerating gradient obtained is above 20 MeV/m for a 4.3-m section length. 4 refs., 5 figs., 1 tab.

31230 Raster scanning magnets for relativistic heavy ions. Milburn, J.E. (Lawrence Berkeley Laboratory, University of California, Berkeley, CA (US)); Tanabe, J.T.; Renner, T.R.; Chu, W.T. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC03-76SF00098. (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

The authors describe a raster scanning system developed for biomedical applications to spread heavy-ion beams with a maximum magnetic rigidity of 8.0 T-m to deliver uniform doses into large target areas, up to 40 cm by 40 cm, at a distance of 6 meters. The scanning system consists of two dipole magnets: the fast magnet with a gap of 5.7 cm height and 10.2 cm width, raster speed of 40 Hz, and maximum field of 0.27 T; and the slow magnet with a gap of 15.2 cm height and 8.9 cm width, scan speed of 0.5 Hz, and 0.34 T field. Both magnets are picture frame type to achieve uniform field across the aperture width. The yoke of the fast magnet is composed of 1.5 mm thick laminations to decrease field perturbations and power loss due to eddy currents. A bifilar type of winding method is used to increase the coil section in the fast magnet, and thus its electrical time constant, which provides for a linear magnetic ramp yield.

31231 Sandia Super-EBIS. Schmieder, R.W. (Sandia National Laboratories, Livermore, California 94551 (US)); Bisson, C.L.; Haney, S.; Toly, N.; Van Hook, A.R.; Weeks, J. *Review of Scientific Instruments (USA)*, 61(1): 259-261 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The Sandia Super-EBIS is a state-of-the-art electron-beam ion source designed to produce extracted beams of ions up to U^{82+} at energies below 1 keV/Q for use in beam-target experiments. It is built around a 1-m-long superconducting solenoid and an electron gun rated up to 80 kV. All aspects of the design have been optimized for efficient extraction of the ions and their transport to the target.

31232 Ion source studies at the ORNL ECR source facility. Meyer, F.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6372 (US)); Hale, J.W. *Review of Scientific Instruments (USA)*, 61(1): 324-326 (Jan 1990). DOE Contract AC05-84OR21400. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Using high resolution magnetic analysis, we have measured energy spreads of Ar^{+q} ($1<q<12$) ion beams extracted from the ORNL ECR ion source under a number of different ECR plasma conditions. The measured energy spreads for the different charge states fall in the range 8–20 eV per charge and are all roughly proportional to the ion charge. In addition, we have used a combination of magnetic and electrostatic analysis to investigate the high charge state tail of the extracted Ar^{+q} charge state distribution. Charge states up to +16 have been positively identified; in addition, tentative identification of extracted Ar^{+17} ions has been made, with total intensity in the range of 10–20 kHz.

31233 Operation of a dc large aperture volume-production H^- source. Kwan, J.W. (Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Ackerman, G.D.; Anderson, O.A.; Chan, C.F.; Cooper, W.S.; deVries, G.J.; Leung, K.N.; Lietzke, A.F.; Steele, W.F. *Review of Scientific Instruments (USA)*, 61(1): 369-371 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

In testing a multicusp volume-production H^- ion source (20 cm diameter, 23 cm long), we optimized the gas pressure, the plasma electrode bias potential, and the magnetic filter. At the optimum pressure of 9 mTorr, the H^- beam output increased linearly with discharge power. The maximum H^- beam, measured with a current transformer downstream of the accelerator, was 100 mA while using a 6.67-cm^2 aperture. Presently we are limited by overheating of the cathodes by the plasma ions. Under similar discharge conditions the maximum H^- current density was found to vary as $a^{-0.7}$, where a is the aperture radius. Results from emittance measurements showed that the effective H^- ion temperature increased with a for $a>0.8$ cm. Thus, the brightness of the beam decreased with increasing aperture radius. Operating the source with cesium would increase the H^- output; however, our accelerator must be improved to avoid breakdowns caused by the cesium contamination.

31234 Performance of a volume H^- ion source with a toroidal discharge chamber. Prelec, K. (AGS Department, Brookhaven National Laboratory, Upton, New York 11973 (US)); Alessi, J.G. *Review of Scientific Instruments (USA)*, 61(1): 415-417 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A new volume H^- ion source with a toroidal discharge chamber has been designed. Its main feature is a full rotational symmetry, including a conically shaped dipole field separating the main toroidal discharge from the central extraction chamber. Measurements of the H^- yield and the accompanying electron component have been performed, both for this rotationally symmetric geometry and for a standard line dipole geometry. With the rotationally symmetric geometry, the H^- yield was up to 30 mA through an aperture of 1 cm^2, while the ratio I_e/I_{H^-} depended greatly on the value of I_{H^-} and was about 20–30 for the highest currents. The beam emittance was measured for the rotationally symmetric geometry, and was found to be ϵ_n (90%)$\approx$0.094 π cm mrad for a 21-mA beam. An estimate of the H^- ion temperature from the measured emittance gives a value of approximately 3.6 eV.

31235 A compact rf-driven, dc ion source. Dooling, J.C. (JAYCOR, Plasma Technology Division, Torrance, California 90503 (US)); Moses, K.G. *Review of Scientific Instruments (USA)*, 61(1):

421-423 (Jan 1990). DOE Contract AC03-86ER80409. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A helium atom beam has been extracted from a rf plasma source with beam energies ranging from 22 to 35 kV. At optimum conditions, a beam of approximately 15 mA equivalent current of 30-keV neutral atoms displays a minimum angular beam divergence of 0.3°. The beam system can be operated continuously in a chopped mode with a 50% duty factor by square-wave modulation of the extraction voltage. Frequency of the modulation can be varied up to 500 Hz. The beam system is also capable of dc operation, having been run in this mode for periods of time exceeding 2 h.

31236 **Extraction-induced emittance growth for negative-ion sources.** Whealton, J.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (US)); Meszaros, P.S.; Raridon, R.J.; Rothe, K.E. *Review of Scientific Instruments (USA),* 61(1): 436-438 (Jan 1990). DOE Contract AC05-84OR21400. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Nonlinear emittance growth produced by ion extraction is considered by a 3-D analysis in a Vlasov–Poisson–Boltzmann formulation. Phenomena considered include (1) presheath effects, including electron depletion, (2) electron sheath accumulation (for large transverse magnetic fields), (3) nonlinear sheath fields (obtained by a self-consistent solution with an assumed quasiequilibrium positive-ion distribution and at least one Vlasov distribution), (4) nonlinear fringe fields produced by the accelerator-extractor itself [obtained self-consistently with item (3) above], (5) nonlinear space charge of the beam itself, and (6) beam in conjunction with extracted electrons. For specific volume negative-ion source configurations, an investigation of the contribution of aberrations caused by an electron trap and electron accumulation in the extraction sheath are studied. Either of these effects can contribute significantly to the beam emittance, possibly dominating the contribution of the negative-ion temperature in the source.

31237 **H^- source and low energy transport for an RFQ preinjector.** Alessi, J.G. (AGS Department, Brookhaven National Laboratory, Upton, New York, 11973 (US)); Brennan, J.M.; Kponou, A. *Review of Scientific Instruments (USA),* 61(1): 625-627 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A radio-frequency quadrupole (RFQ) accelerator has replaced a 750-keV Cockcroft-Walton as the H^- preinjector for the Brookhaven alternating gradient synchrotron. A magnetron surface-plasma source with a circular aperture is used to produce 65–100 mA of H^- at 35 keV with a discharge current of less than 20 A. The symmetry of the beam is maintained in the 2-m transport to the RFQ via the use of magnetic solenoids for focusing. Currents up to 60 mA have been obtained out of the RFQ. A traveling-wave electrostatic chopper in the 35-keV transport line leads to a distortion of the emittance due to space-charge effects.

31238 **High voltage pulse conditioning.** Springfield, R.M.; Wheat, R.M. To U.S. Dept. of Energy, Washington, DC. USA Patent 4897556/A/. 30 Jan 1990. Filed date 21 Feb 1989. USA Patent Application 7-313,201. Int. Cl. H03K 3/537. 4p.

This patent describes an apparatus for conditioning high voltage pulses from particle accelerators in order to shorten the rise times of the pulses. Flashover switches in the cathode stalk of the transmission line hold off conduction for a determinable period of time, reflecting the early portion of the pulses. Diodes upstream of the switches divert energy into the magnetic and electrostatic storage of the capacitance and inductance inherent to the transmission line until the switches close.

4304 Storage Rings

Refer also to citation(s) 31063, 31078, 31091, 31092, 31095, 31096, 31097, 31179, 31186, 31194, 31196, 31208, 31210, 31217, 31218, 31748, 31749, 31752

31239 (BESSY-TB–140/89-COSY) **Superconducting storage ring development at BESSY - new results from COSY.** Anders, W. (Berliner Elektronenspeicherring-Gesellschaft fuer Synchrotronstrahlung mbH (BESSY), Berlin (Germany, F.R.)); Buerkmann, K.; Egan-Krieger, G. v.; Hartrott, M. v.; Lehr, H.; Martin, M.; Mueller, R.; Schulz, L.; Weihreter, E.; Oertel, D. Berliner Elektronenspeicherring-Gesellschaft fuer Synchrotronstrahlung mbH (BESSY), Berlin (Germany, F.R.). Jul 1989. 21p. (CONF-8907130–: 9. international conference on vacuum ultraviolet radiation physics, Honolulu, HI (USA), 17-21 Jul 1989). Available from Berliner Elektronenspeicherring-Gesellschaft fuer Synchrotronstrahlung mbH (BESSY), Berlin (Germany, F.R.).

To extend the use of synchrotron radiation outside the field of fundamental research, superconducting compact storage rings are under development worldwide. The basic concepts of such SR sources are presented with a brief outline of the main development problems. The COSY ring at BESSY has been designed as a prototype of a compact source for X-ray lithography. After detailed studies with normal conducting magnets, commissioning with the superconducting magnets began in spring last year. The first electron beam was stored in this machine in November 1988, a milestone in the development of superconducting compact storage rings. In the meantime the energy has been raised up to 360 MeV. The main characteristics of COSY are reported together with the latest results. (orig.).

31240 (KEK–89-2, pp. 68-73) **Design and thermal analysis of crotch for 8GeV storage ring.** Morimoto, Yoshihide (Institute of Physical and Chemical Research, Wako, Saitama (Japan)); Yokouchi, Shigeru; Sakamoto, Hiroyuki; Ri, Eihaku; Oikawa, Yoshiro; Saku, Heibe. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The report describes the structure of a crotch specially designed for an 8GeV storage ring, and presents major results of a thermal analysis carried out to demonstrate its heat resistance under synchrotron orbit radiation. The crotch developed has the following features: (1) a special chamber is provided to gaseous molecules and other particles produced by secondary electrons, reflected radiation or photodesorption, (2) not only the directly irradiated portion but the whole unit is made of oxygen-free copper (Class 1), and (3) three types of large-capacity pumps (NEG pump, ion pump, titanium sublimation pump) are provided to discharge the released gas. The crotch consists of a channel to pass the electron beam and a chamber to trap released gaseous molecules and other particles. The electron beam channel has the same cross-sectional profile as the storage ring chambers that are connected to each end of the channel so as to minimize the high-mode loss associated with the passage of electrons. Two absorbers made of oxygen-free copper are provided to absorb the energy of the synchrotron orbit radiation. Results of the thermal analysis demonstrates that the crotch has a satisfactory performance. (N.K.).

31241 **Injector linac for Super-ALIS.** Hosokawa, T. (NTT LSI Laboratories, Kanagawa (Japan)); Kitayama, T.; Hayasaka, T.; Ido, S.; Uno, Y.; Shibayama, A.; Nakata, J.; Nishimura, K.; Nakajima, M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An injector linac is described for Super-ALIS, the dedicated superconducting storage ring to X-ray lithography at NTT LSI Laboratories. Super-ALIS employs a low energy injection scheme. In this scheme, injection efficiency needs to be raised, since stacking is unavailable due to Super-ALIS's low injection energy levels. Strict requirements had to be met in order to improve the efficiency of the injector: large current, low transverse emittance and a narrow energy spread. A low emittance electron gun, double prebunchers, standing-wave accelerator cavities and an ECS were used in the injector to fulfill those requirements. The characteristics of the system are summarized below. Acceleration frequency is

2856.65 MHz. Beam energy and current are 15 MeV and 270mA, respectively. Beam energy spread is 1% (FW). Beam pulse width is 2 μ s. Maximum repetition rate is 3 Hz. 7 refs., 5 figs., 1 tab.

31242 High precision real time beam position measurement system. Kleman, K.J. (Univ. of Wisconsin, Madison (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A system for real time measurement of beam position is being constructed for the ALADDIN electron storage ring. High precision measurements with a bandwidth large enough to allow their use in closed orbit feedback are required. The hardware at each station consists of a pair of position sensing electrodes connected through a PIN diode switch to a narrow band receiver tuned to the second harmonic of the storage ring RF frequency. The receiver input is switched between the electrodes at a 12.5 kHz rate. The output of the receiver is synchronously demodulated to obtain a signal proportional to the difference between the electrode signals. The difference signal is normalized to beam intensity with an automatic gain control (AGC) loop controlling the average output of the receiver. The AGC loop has a useful dynamic range of 80 dB and is capable of reducing beam signal fluctuations at frequencies up to 200 Hz. 1 ref., 6 figs.

31243 Results of measurements of the HERA proton beam position monitors. Shuette, W. (Deutsches Elektronen-Synchrotron, Hamburg (Germany, F.R.)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A beam position monitoring system has been designed for the 820 GeV HERA proton storage ring accelerator. There will be 243 pickups of the directional coupler type in the ring. The vacuum, mechanical and electrical properties of each must be measured. These measurements ensure good quality and form the basis for determination of the beam orbit position relative to the corresponding quadrupole axis. The results of the measurements and the alignment procedure are described. 7 refs., 2 figs.

31244 Electrostatic beam separation system of TRISTAN main ring. Shintake, T. (KEK National Laboratory for High Energy Physics, Ibaraki (Japan)); Suetsugu, Y.; Mori, K.; Sato, M.; Higo, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Sixteen electrostatic separators have been installed in TRISTAN Main Ring. The maximum designed voltage is 240 kV, across a gap of 8 cm between 4.6 or 3.2 m long titanium electrodes. In order to make the H.V. sparking rate as low as possible, the chemical cleaning process of the electrodes and the chamber surfaces were studied carefully. Every one of the H.V.-busing and ceramic supports were tested by applying H.V. up to 150 kV, and assembled into the separator chamber in a clean room. Special care was taken to secure the passage of the wall current produced by the passing bunched beam, so that no H.V. breakdown will occur. The power of the parasitic mode was pulled out and damped by the ferrite microwave absorbers inside the shield box so that the direct cooling of the electrodes became unnecessary, and the structure of the separator became very simple. The separator showed excellent H.V. properties, i.e., no H.V. spark was observed over two days for 16 separators at 240 kV without the beam circulating the ring. With beams of 9 mA total current, neither beam loss nor sparks were observed at the separation voltage of 200 kV. 6 refs., 5 figs.

31245 The LEP injection monitors: Design and first results with beam. Burtin, G. (European Organization for Nuclear Research CERN, Geneva (Switzerland)); Colchester, R.; Fischer, C.; Halvarsson, B.; Hemery, J.Y.; Jung, R.; Levitt, S.; Vouillot, J.M. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The LEP injection monitors comprise of split foil monitors, luminescent screens and beam stoppers. The monitors are described with particular emphasis on their special features. These include: their low loss factors, their protection against synchrotron radiation and the screen read-out with a CCD chip. The results obtained during the positron injection tests in LEP in July 1988 are reported. 8 figs.

31246 Phase space profile measurement using an x-ray pinhole camera. Ogata, A. (National Laboratory for High Energy Physics, Ibaraki-ken (Japan)); Mitsuhashi, T.; Katsura, T.; Yamamoto, N.; Kawamoto, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

Transverse beam profiles in the real (x,y) and phase (y,y′) spaces are obtained by an X-ray pinhole camera sensitive to synchrotron radiation in the TRISTAN Accumulation ring (AR). Vertical Twiss parameters, and the vertical and horizontal emittances are derived from the profiles. A pinhole cannot vertically see the whole beam, because of the small cone angle of the radiation. The following two measurements were tried to solve this problem. The first measurement was made by moving the pinhole vertically. The second was made by using multiple pinhole plate. An image on a fluorescent screen is observed by a CCD camera, digitized and stored. The phase space and the real space profiles are then reconstructed. A non-linear least square program fits the resultant profiles to a two dimensional Gaussian distributions to derive the Twiss parameters and emittances. 2 refs., 5 figs.

31247 Impedance measurements on button electrodes. Jacob, A. (Lawrence Berkeley Laboratory, Berkeley, CA (USA)); Lambertson, G.R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

In the Advanced Light Source, there will be about 400 capacitive button electrodes in the beam position monitor (BPM) system, hence the contribution of each button to the machine beam impedance must be very small. The authors have measured the impedance of a single button as sensed by a coax connected directly to the button surface. This method is very sensitive and did not require a model of the total beam chamber as would the usual wire method. The measurements covered the range 0.1- to -20 GHz. The proportionality factor between the button impedance and the beam impedance depends upon geometry and frequency and was obtained from the measured sensitivity of a developmental BPM at low frequency. Discontinuities in the connection of the coax to the face of the button introduce parasitic effects that must be accounted for in interpreting the data. Below 5 GHz the results compare very well with responses computed from mechanical dimensions of the electrode. Above 15 GHz corrections for the parasitic elements become more uncertain but the accuracy of the method is still adequate. The results show multiple resonances, a prominent example being for one button a beam impedance peak of ~1 ohm with a Q of 500 at 16 GHz. 2 refs., 7 figs.

31248 Advanced Light Sources (ALS) beam position monitors. Hinkson, J. (Univ. of California, Berkeley (USA)); Johnston, J.; Ko, I. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The ALS is a third-generation synchrotron light source currently under construction at LBL. The accelerator complex will consist of a 1-2GeV electron storage ring, a 1.5GeV booster synchrotron, a 50MeV linac, and low and high energy beam transfer lines. Beam pickup devices and electronic instrumentation have been specified for the accelerator, and development of the beam position monitor (BPM) systems is well under way. Considerable effort has gone into the storage ring BPM system design in particular because of the need for very fast and accurate measurements. The authors meet the speed and accuracy requirements in the electronics with parallel processing and error correction techniques. A tuned receiver is provided for every beam position pickup, and for every array of four pickups there is a microprocessor controlling the measurement and recording the data. In this paper the authors report on the requirements, design, and performance of the storage ring BPM system. 3 refs., 3 figs.

31249 **Switched detector for beam position monitor.** Biscardi, R. (National Synchrotron Light Source, Upton, NY (USA)); Bittner, J.W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The NSLS storage rings use sets of four button electrodes to determine the transverse position of the stored electron beam in the vacuum chamber. By means of GaAs switches, the 211 MHz component of the induced signals on each of the four buttons is measured in turn by a single amplifier/detector channel. These signals are then stored in four sample and hold circuits. The measurement cycle is repeated at a rate of 40 KHz. The required sums and difference of these signals are obtained by analog means. The results are normalized with respect to beam intensity by servoing the gain of the amplifier/detector channel such that the sum of the signals from the four buttons is maintained at a fixed value. 4 refs., 3 figs.

31250 **A noniterative method for calculating beam position from induced electric signals.** Bozoki, E.S. (Brookhaven National Laboratory, Upton, NY (USA)); Huang, J.Y.; Bittner, J.W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

With more and more sophisticated experiments and the installation of insertion devices, the need for stability of the electron beam orbit in the NSLS storage rings has increased over the past few years. This requires more accurate measurement and better control the better control of the orbit. As part of the effort to be able to control the beam orbit to $\approx 50\mu m$ accuracy, new method of orbit correction was worked out [1] and the orbit monitor electronics is being upgraded [2]. It has become increasingly important to develop an algorithm that can be used to correct for the nonlinearities in the beam position measuring system. With the aid of a bench measurement the authors have developed such an algorithm. The present paper describes this effort. The PUE's (electrodes) in the NSLS storage rings are of the 4 button type. Near the center of the PUE the beam position can be well approximated with a linear function of the sum and the difference signals induced on these electrodes by the bunched beam. The nonlinear response of the PUE's further away from the center was measured. An algorithm was developed to compensate for this effect. 7 refs., 5 figs. 1 tab.

31251 **Beam position monitor upgrade for the Los Alamos Proton Storage Ring.** Shafer, R.E. (Los Alamos National Laboratory, NM (USA)); Swain, G.; Thiessen, H.A.; Macek, R.; Mackenzie, G.; Rawnsley, W. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The beam diagnostics for the Los Alamos Proton Storage Ring (PSR) are being upgraded in several areas, including the closed-orbit beam position system, the high-frequency longitudinal and transverse beam diagnostics, and the extraction line beam-position monitoring system. This paper describes the basic design of these new systems. The present closed-orbit beam-position measuring system is based on detecting the 201-MHz modulation on the injected beam, which disappears in about 10 μsec, due primarily to the momentum spread of the beam (about $\pm$ 0.1%), and the consequent spread in the revolution frequencies. Thus, although the first few turns of injected beam is monitored with the present system, the main body of the stored beam, which has lost its 201-MHz component, is not. In order to monitor the position of the stored beam, the ring beam-position system is being re-designed to operate at the revolution frequency, 2.8 MHz. 4 refs., 3 figs.

31252 **Coupling-impedance and response characterization measurements of a proton storage ring wall-current monitor.** Walling, L.S. (Los Alamos National Laboratory, NM (USA)); McMurry, D.E.; Thiessen, H.A.; Neuffer, D. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper describes a method to measure the response of a beam current monitor and reports response and impedance measurement results for a Proton Storage Ring (PSR) wall current monitor. The authors have reported a Through-Short-Delay (TSD) calibration method for making coupling-impedance measurements. The authors now describe extending this method to measure the response of a current monitor that is imbedded within hardware that interfaces to a network analyzer. The authors utilize error correction parameters that are generated using the TSD-calibration to calculate the actual current present at the current monitor. 1 ref., 11 figs.

31253 **Timing and RF synchronization for filling PEP/SPEAR with the SLC damping rings.** Ronan, M.T. (Lawrence Berkeley Laboratory, CA (USA)); Lambert, D.J.; Lee, K.L.; Bernstein, D.R.; Corredoura, P.; Jobe, R.K.; Ross, M.C.; Roster, B.; Vancraeynest, J.; Zapalac, G. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

An innovative timing and RF synchronization system has been built and commissioned which allows the direct injection of 1 mm σ_z e^+ or e^- bunches from the SLC Damping Rings (ν_{RF} = 714 MHz) into the storage rings PEP (ν_{RF} = 353 MHz) and SPEAR (ν_{RF} = 358 MHz). The required relative stability of these oscillators is 10^{-9} since the beams may be stored in each damping ring (DR) for up to 0.2 sec., during which no timing correction is made, and must be delivered within a 0.5 nsec window. This stability has been obtained by phase-locking the storage ring RF to the LINAC-DR master oscillator. In order to obtain bunched beams for acceleration in the LINAC 10.5 cm RF structure while maintaining the storage ring timing requirements, the Subharmonic Buncher and Damping Ring RF are phase-shifted using GaAs digital circuitry. This paper describes (1) the phase-locked loops, (2) the RF distribution system, (3) the S-band resettable dividers and (4) the interpulse timing system components used in this project. 4 refs., 4 figs.

31254 **A dedicated multi-process controller for a LEP RF unit.** Ciapala, E. (CERN, Geneva (Switzerland)); Collier, P. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The operation of each RF unit for LEP requires that several control processes can be run at the same time. Local and remote access is required to around 2,500 individual parameters and status indications inside the unit. Normal operation of the unit involves

complex procedures involving a considerable amount of sequential access of equipment within the unit. Optimum performance and overall maintainability is achieved by calling up locally resident procedures. In addition the surveillance and alarm monitoring needed can run locally, making a summary status available for the control center. The local process controller (data manager) hardware is realized as a hybrid VME/G64 crate with a 68020 VME module as the main processor. Two 68000 VME slave processors having G64 ports handle communication with equipment buses. VME high resolution graphics interfaces provide interactive local control via a touch screen and seperate data display. A VME MIL-1553 interface provides the connection to the control system. Local control, remote control and surveillance run concurrently on the main processor under the OS-9/68K multitasking operating system. Apart from specific device drivers all software is written in C. 4 refs., 4 figs.

31255 Progress in commissioning the IUCF cooler. Ellison, T.J. (Indiana Univ. Cyclotron Facility, Bloomington (USA)); Jones, W.P.; Collins, J.C.; Friesel, D.L.; Schwandt, P.; Sloan, T. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

This paper will describe some of the techniques used and results observed during the commissioning of the IUCF electron cooled storage ring. Measurements of machine properties and their comparison with design values, methods of closed orbit corrections, and the methods used in ramping the beam to higher energies will be discussed. Plans for enhancing the performance of the ring will be described. 4 refs., 5 figs.

31256 Phase and voltage control in the LEP radio-frequency system. Juillard, J.C. (CERN, Geneva (Switzerland)); Peschardt, E. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The LEP RF system is of modular construction where a basic module, an RF unit, consists of 16 coupled accelerating cavity/storage cavity assemblies driven by two 1MW klystrons. The two klystrons operate at slightly different frequencies f_1 and f_2 with the difference determined by the bunch spacing in LEP. The units are synchronized with the frequencies f_0 = 352.254024 MHz and f_B = 44.982 kHz. They are transmitted to the RF stations from the LEP control center over fiber optic links. The klystron phase loop compensates for phase variations in the kylstron and the circulator. The input power to the klystrons is controlled from the drive level control system which includes an AGC loop. This loop compensates for gain variations in the narrow-band, high gain, 200 W solid state driver amplifier. The cavity gap voltage is controlled with a voltage loop which acts on the modulation anode of the klystron. The correct waveform is obtained with a differential loop which corrects for differences in output power from the two klystrons. For use in the servo loops 350 MHz control elements have been developed. The most important are the voltage controlled attenuators with low phase shift variations and the voltage detectors with low VSWR. 6 refs., 8 figs.

31257 Architecture and performance of the new CESR control system. Strohman, C.R. (Cornell Univ., Ithaca, NY (USA)); Peck, S.B. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The new control system for the Cornell Electron Storage Ring (CESR) is based on a multi-port memory which can be accessed by many computers. The computers are either VAXes, which run user programs, or Xbus Processors, which move data to and from the hardware devices which are being monitored or controlled. The control system database is in the multi-port memory, and contains all of the data needed to communicate with various pieces of hardware. 1 fig.

31258 Optics of the Amsterdam Pulse Stretcher (AmPS). Mass, R. (NIKHEF-K, Amsterdam (Netherlands)); Wu, Y.Y. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The AmPS machine has been designed as a dual-purpose machine: it will be used both as a Pulse Stretcher (PS) and as a storage ring for electrons. In the latter mode the stored beam will be used in conjunction with an internal (jet) target. Since the internal target will limit the lifetime of the beam to minutes, the storage requirements (e.g. vacuum) will be modest. In PS mode the energy range is 250 - 800 MeV; in storage mode the range is extended to 900 MeV. It is anticipated to store a current of up to 200 mA. 8 refs., 5 figs., 1 tab.

31259 Design for a second-generation proton storage ring at LAMPF. Colton, E.P. (Los Alamos National Laboratory, NM (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

A conceptual design is presented for a second-generation proton storage ring complex at LAMPF. The facility would consist of two stacked racetrack-shaped machines. These machines would deliver a 1.2-mA beam of 1.6-GeV protons at 48 Hz. The pulse length would be 1.75 μsec which represents a time compression of 570. 3 refs., 4 figs., 1 tab.

31260 An energy spectrum compressor system (ECS) for the Amsterdam Pulse Stretcher (AmPS). Noomen, J.G. (NIKHEF-K, Amsterdam (Netherlands)); Maas, R. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

To obtain high duty (90%) electron beams, the present 2% d.f. 500 MeV linac (MEA) will be modified into a low d.f. (0.1%) injector for the pulse stretcher ring presently under construction. The accelerator peak current has to be increased from 10 mA to 80 mA to obtain from the pulse stretcher an average current of 65 μA. The resulting increase of the energy spread from 0.3% to 1 - 2% requires the installation of an energy compression system (ESC) to match the 0.2% acceptance of the pulse stretcher. The ESC consists of four magnets followed by a short-filling time r.f. traveling wave accelerator structure. Considerations concerning required energy range, beam loading, phase errors, and current ripple which determine the longitudinal dispersion and the required r.f. power source are presented. 6 refs., 3 figs., 3 tabs.

31261 The positron accumulator ring for the APS. Crosbie, E.A. (Argonne National Laboratory, IL (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Positron Accumulator Ring (PAR) is designed to accumulate and damp positrons from the 450-MeV linac during the 0.5-s cycle time of the injector synchrotron for the APS 7-GeV storage ring. During 0.4 s of each synchrotron cycle, up to 24 linac pulses are injected into the horizontal phase space of the PAR at a 60-Hz rate. Each injected pulse occupies about 1/3 of the circumference of the accumulator ring. After 0.1 s for longitudinal damping, the single accumulated bunch is transferred to one of the 353-MHz buckets of the injector synchrotron RF system. The bunch is accelerated to 7 GeV and transferred to the storage ring, while the PAR accumulates the next bunch of positrons. 2 refs., 3 figs., 2 tabs.

31262 More bunches in LEP. Jowett, J.M. (CERN, Geneva (Switzerland)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

LEP has been designed to operate with 4 bunches in each beam. In view of the physics interest, the author considers the possibility of increasing the number of bunches in order to provide a higher luminosity at the Z^0-resonance. Unwanted head-on collisions can be avoided by horizontal separation in a four-fold pretzel scheme analogous to the one employed in CESR and requiring additional electrostatic separators, working independently of those already foreseen. Residual beam-beam effects are minimized by selecting an optimum combination of bunch number and optics. Modifications of the standard LEP optics and RF system are necessary. The authors discuss the performance which could be expected with such a scheme, criteria for evaluating it and the factors which limit it. 9 refs., 3 figs., 1 tab.

31263 CESR [Cornell Electron Storage Ring] plus. Rubin, D.L. (Cornell Univ., Ithaca, NY (USA)). pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The Cornell Electron Storage Ring operates with seven bunches per beam and 11ma per bunch to yield a peak luminosity of $1 \times 10^{32} cm^{-1} s^{-1}$ at each of two interaction points. An electrostatic orbit distortion separates the beams at the 12 parasitic crossings. The beam-beam limited luminosity can be significantly increased by reducing the number of interaction points to one. The fraction of a radiation damping time per collision at the remaining interaction point is thereby doubled. Because one of two sets of low beta optics can be removed, the integer part of the horizontal tune can be increased to 13 from 9 permitting operation with fourteen bunches per beam, and the beam width at the single interaction point can be enhanced. Currents of about 300ma/beam will be required to operate the upgraded machine at its beam-beam limited luminosity in excess of 5×10^{32} $cm^{-2} s^{-1}$ and the associated upgrade of the single beam current carrying capability are described. 15 refs., 2 figs.

31264 Upgrade of beam steering system components and controls for the NSLS storage rings. Singh, O.V. (Brookhaven National Laboratory, Upton, NY (USA)); Nawrocky, R.J. pp. 678 of Proceedings of the 1989 IEEE (Institute of Electrical and Electronics Engineers) particle accelerator conference. Volume 3. Bennett, F.; Kopta, J. (eds.). Institute of Electrical and Electronics Engineers, New York, NY (US) (1989). (CONF-890335–Vol.3: 1989 IEEE particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989).

The installation of the new insertion devices and new experiments on the NSLS storage rings has increased the demand for better stability of the electron orbit. This, in turn, increased the demand for better stability and resolution as well as larger bandwidth of the orbit correction system. All of the orbit correcting dipoles now have new low-hysteresis laminated steel cores. The magnets are excited by commercial wide-band (1 kHz) current regulated power supplies. The input circuits of the new power supplies permit a summation of analog inputs from orbit stabilization systems with set-point inputs digitally controlled by the operator. This paper describes the design of the new system and summarizes its present performance. 2 refs., 8 figs., 1 tab.

44 INSTRUMENTATION

4401 Radiation Instrumentation

Refer also to citation(s) 30170, 30181, 30327, 30355, 31127, 31230, 31339, 31955

31265 (AD-A–217506/5/XAB) **Experimental testing of corpuscular-radiation detectors. Volume 1. Revision 1. Final report, 1 November 1987-31 January 1989.** Grossi, M.D. Raytheon Co., Portsmouth, RI (USA). Submarine Signal Div. 7 Sep 1989. 162p. (CN-RA–0063-REV-1). Available from NTIS, PC A08/MF A01.

See also Volume 2, AD-A217 507.

Observations were performed by using Prof. Joe Weber's torsion balance, a room-temperature instrument that was constructed by University of Maryland under a subcontract from Raytheon, and was installed at LANL in Summer 1988. The torsion balance was mounted at a fixed location, close to the edge of a rotating table (1 RPM rotational speed) that Raytheon had constructed and moved to Los Alamos, NM. As the table rotated, the tritium-filled container (neutrino source) and the deuterium filled container (that provided a Newtonian force reference) were sensed by the instrument. At the time of writing this report, the results of the measurements are not fully conclusive. A six-month Contract extension, expected to last until 31 December 1989, will provide the final answer whether or not we could observe repulsion forces, attributable to neutrino pressure, with the torsion balance.

31266 (AD-A–217507/3/XAB) **Experimental testing of corpuscular-radiation detectors. Volume 2. Revision 1. Final report, 1 November 1987-31 January 1989.** Grossi, M.D. Raytheon Co., Portsmouth, RI (USA). Submarine Signal Div. 7 Sep 1989. 224p. (CN-RA–0064-REV-1). Available from NTIS, PC A10/MF A02.

See also Volume 1, AD-A217 506.

Observations were performed by using Prof. Joe Weber's torsion balance, a room-temperature instrument that was constructed by University of Maryland under a subcontract from Raytheon, and was installed at LANL in Summer 1988. The torsion balance was mounted at a fixed location, close to the edge of a rotating table (1 RPM rotational speed) that Raytheon had constructed and moved to Los Alamos, NM. As the table rotated, the tritium-filled container (neutrino source) and the deuterium-filled container (that provided a newtonian force reference) were sensed by the instrument. At the time of writing of this Report, the results of the measurements are not fully conclusive. A six-month Contract extension, expected to last until 31 December 1989, will provide the final answer whether or not we could observe repulsion forces, attributable to neutrino pressure, with the torsion balance.

31267 (AD-A–217596/6/XAB) **Feasibility of event sequence discrimination for the improvement of gamma-ray spectrometer sensitivity. Final report, May 1985-November 1989.** Walker, D.M.; Wahlig, B.G.; Gillespie, J.G. Quantum Technology, Inc., Marietta, GA (USA). 29 Dec 1989. 114p. Available from NTIS, PC A06/MF A01.

Nuclear measurement applications for military surveillance, environmental monitoring, and physics research are bounded by detection sensitivity and counting time limitations. To date, improvements in detection sensitivity for semiconductor detectors have been limited to small incremental gains made primarily through increased crystal size and purity. The results of this study indicate that a step improvement in the gamma ray detection sensitivity of semiconductor detectors is achievable if information on each scattering sequence can be processed and used on a livetime basis to accept preferentially the full energy event sequences, and to reject false partial energy event sequences. In this study, a Monte Carlo model for gamma ray interactions in germanium was developed and used to select criteria on interaction location and number of events which are predicted to improve detector performance. The sensitivity of a detector system was determined from the Monte Carlo model results for five gamma ray energies in the range 88 keV to 1836 keV, under several event discrimination criteria.

31268 (BMVg-FBWM–90-5) **Lyoluminescence of saccharides for radiation dose determination (personnel dosimetry) in armed forces. Final report.** Koch, M.; Nickel, T.; Pitt, E.; Scharmann, A. Bundesministerium der Verteidigung, Bonn (Germany, F.R.); Giessen Univ. (Germany, F.R.). 1. Physikalisches Inst. 1990. 48p. (In German). Contract InSan I 0785-V-3886. Available from Bundesministerium der Verteidigung, Bonn (Germany,

F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw).

The chemiluminescence of saccharides (lyoluminescence) after exposure to γ-radiation is a method for personnel dosimetry in the upper dose range up to 10 Gy. The principal usefulness for military application has been investigated for 24 saccharides. Fructose has proved to be the most suitable material. Dose and energy dependence have been determined. The dosemeter design has been specified with respect to environmental influences. Advantages and disadvantages as compared with RPL-dosimetry are pointed out. (orig.) With 25 refs.

31269 (BONN-IR-88-35) **A gas monitoring facility with a quadrupole mass spectrometer for the ZEUS transition-radiation chambers.** Kapp, U. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Jul 1988. 48p. (In German). Order Number DE90785076. Available from NTIS (US Sales Only), PC A03/MF A01.

A gas analysis facility for the ZEUS transition-radiation chambers based on a quadrupole mass spectrometer is described. After a description of the spectrometer, the vacuum system, and the software, some test results are presented. (HSI).

31270 (BONN-IR-89-53) **A measuring apparature for the laser calibration of the planar drift chambers of the ZEUS detector - studies with magnetic field.** Stratmann, R. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1989. 61p. (In German). Order Number DE90785077. Available from NTIS (US Sales Only), PC A04/MF A01.

The planar drift chambers of the ZEUS forward detector have to be operated in an inhomogeneous magnetic field with a maximum field gradient of 1 T/m. For the calibration of these chambers we measured the space-drifttime-relations for various configurations of E vector and B vector. The experimental setup consists of a test cell placed in the gap of a dipole magnet. The orientation of the cell w.r.t. the magnetic field can be varied with a computer controlled mechanical support. The tracks were generated by an UV-laser beam, which is appropriately directed into the cell by a system of 3 mirrors. In Ar/C_2H_6 (50/50) we obtained almost linear space-drifttime-relations. The effective drift velocity varies from (50.6$\pm$0.7) μm/ns at B vector=0 T to (33.5$\pm$0.7) μm/ns at B vector=1.51 T (B vector-field parallel to wireplane). The addition of a few percents of ethanol to the chamber gas causes an increase of the effective drift velocity by up to 3 μm/ns. (orig.).

31271 (BONN-IR-90-01) **Simulation calculations on the construction of the energy-tagged photon beam as well as development and test of the side drift chambers of the Bonn SAPHIR detector.** Jahnen, T. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Jan 1990. 85p. (In German). Order Number DE90785079. Available from NTIS (US Sales Only), PC A05/MF A01.

The SAPHIR-detector is built up at the continuous photon beam of the Electron Stretcher and Accelerator ELSA in Bonn. The equipment is designed for investigations of reactions with more then two particles in the final state and for photon energies up to 3.5 GeV. A tagging-system determines the energy of the Bremsstrahlung-photons and a set-up of five large driftchambers measures the tracks of the charged particles. This work describes a program which was used to develop the best design of the tagging-hodoscope. In a second part the tests of the planar side-chambers and their evaluation is described. These measurements were carried out to fix the gasfilling and the parameters of the best working point. It is shown, that the chambers can reach a resolution of $\sigma \leq 200$ μm. (orig.).

31272 (CNIC-00165) **Data acquisition and processing system based on APPLE-II.** Wang Jihai (Southwest Inst. of Physics, Leshan, SC (China)). China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 6p. (In Chinese). (SIP-0024). Order Number DE90626914. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A data acquisition and processing system is developed. It has complete function, high generality and feature. Using, modifying and extending is very easy. There are data collecting, data saving, data loading, graph plotting, graph displaying, data printing and data processing in the system. Experimenter may set the delay time, synchronous voltage, collection rate, experimental parameters and conditions. Experimental data, parameters and conditions are related each other, and saved into a file for analysing and comparing. This system is designed for all kinds of small experimental devices. In 1986 $\approx$ 1987, it already has been applied to experimental devices MM-2 and MM_4, and several important experimental results have been obtained.

31273 (CNIC-00222) **Induced mutation breeding by fast neutron: Selection and utilization of rice 'Zhongtie 31'.** Chen Zhengba (Guangdong Inst. of Test and Analysis, Guangzhou (China)); You Risheng. China Nuclear Information Centre, Beijing, BJ (China). Sep 1988. 9p. (In Chinese). (GD-ITA-0022). Order Number DE90626915. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The high-yield and long-grain new variety 'Zhongtie 31' was developed through five generations after irradiation of the rice variety 'Tieqiu 15' dried seeds by 14 MeV fast neutrons with a fluence of (1.33 $\approx$ 3.33) x 10^{11} neutrons cm^{-2}. It matured earlier 3 to 5 days, the plant is higher 10 cm, bigger ear, more grain than its original variety 'tieqiu 15', and the yield increased by 19.2% to 30.7%. The source of new variety 'Zhongtie 31' was proved by the isoenzyme genetics. In field test, it increased by 7% to 10% as compared with high-yield variety 'Guichao No.2' and the hybrid rive 'Shanyou No.2', and is more palatable. The new variety was initiated by irradiation mutagensis routine rice, its well-grown and bumper-yield performances may be compared favourably with hybrid rice variety. In July 1986, the new variety 'Zhongtie 31' was obtained by inducing mutation with fast neutron. The same year, the planted area of 'Zhongtie 31' has achieved upto 250 thousand mu (1.67 x 10^8 cm^2).

31274 (CNIC-00242) **Absolute measurement and international intercomparison of 0.1-0.8 MeV monoenergetic neutron fluence rate.** Ma Hongchang (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Lu Hanlin; Rong Chaofan. China Nuclear Information Centre, Beijing, BJ (China). 1988. 14p. (In Chinese). (IAE-0054). Order Number DE90626917. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The methods for absolute measurement of 0.1-18MeV monoenergetic neutron fluence rate are described. Which include proton recoil telescope, semicoducetor telescope, hydrogen filled proportional counter and associated particale method. A long counter used as secondary recent international intercomparison of neutron fluence rate organized by BIPM, and the results were given.

31275 (CNIC-00253) **Electrostatic compensation and geometric corrections for widely extended source of magnetic β spectrometer.** Mao Naifeng (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Liang Dongqi; Sun Hancheng. China Nuclear Information Centre, Beijing, BJ (China). 1988. 9p. (In Chinese). (IAE-0065). Order Number DE90626950. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Measuring the end-point-region of the tritium β-sepectrum is the most sensitiv method to serach the rest mass of electron anti-neutrion. The application of a widely extended β source can notably improve the luminosity of the β spectrometer under conditions of high-resolution. The electrostatic compensation and geometric corrections of the widely extended source are investigated in second-order and high-order approximations with transfer matrix and ray-tracing methods respectively. The ideal configurations of the widely extended source and the equipotential lines on the source surface are calculated, and their cylindrical surface approximation and circular are approximation are also discussed. An example of the widely extended source of 9.6 cm in width and 10.0 cm in height is given on the basis of the magnetic field parameters of the β spectrometer used to search the rest mass of neutrino at Institute of Atomic Energy, Beijing. By applying the widely extended source, the luminosity of the β spectrometer can increase by a factor of more than two orders of magnitude, while the resolution increases by a factor of only about two. The results of theoretical calculation and experiments are in good agreement with each other.

31276 (CNIC–00278) **Calibrating instrument of plane sources of alpha and beta.** Liu Hongquan (Southwest Inst. of Materials, SC (China)). China Nuclear Information Centre, Beijing, BJ (China). Dec 1988. 12p. (In Chinese). (SIM–0001). Order Number DE90626918. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The instrument is standard instrument for measuring emissivity of plane sources of alpha and beta under 2π geometry in radionuclide metrologic technique. It is composed of box-type detector and truck-type NIM (made in China) to make up integral equipment. Its detector is composed of multivire proportion counter with electrostatic screen of zero potential and unique anticoincidence multiwire proportion counter in lead chamber. The characteristics of the instrument are as follows: Low background ($\alpha \leq$ 0.006 C · P · M/cm^2, $\beta \leq$ 0.03 C · P · M/cm^2), low work voltage, low noise, high detective efficiency (>99%), large sensitive area (150 x 100 mm), less dead time, possessing micro accidental anticoincidences, better property of high voltage plateau and discriminating. It has fulfilled the requirements of standard which possesses wide rang (50 C · M · M $\approx 10^6$ C · P · M), high precision ($\pm$ 5 $\approx$ 6% for 50 C · P · M $\approx$ 220 C · P · M, $\leq \pm$ 0.6% for 200 C · P · M $\approx 10^6$ C · P · M); besides, have solved the problem of instability which usualy occurs in same kind of equipments for measuring a sources with less face conductivity.

31277 (CONF-900563–2) **Dual silicon surface-barrier detectors and associated electronics for monitoring chemical separation of ^{249}Cf and ^{249}Bk.** Chiles, M.M. Oak Ridge National Lab., TN (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990. Order Number DE90010436. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The isotopes ^{249}Cf and ^{249}Bk are chemically separated by ion exchange chromatography at the Oak Ridge National Laboratory Transuranium Processing Plant. Control of the separation depends on the operator's ability to distinguish electronically between alpha radiation from the ^{249}Cf and beta particles from the ^{249}Bk. This new monitoring system consists of two surface-barrier detectors, each having its own channel of electronics and data acquisition. The two detectors are mounted in a Teflon holder and positioned near the tip of the ion exchange column, where droplets of solution are formed as the nuclides are eluted from the column. Amplifier gain and window settings on the single-channel analyzer (SCA) for one detector are adjusted to count the energetic alpha particles from the ^{249}Cf, while the electronic settings of the other channel are adjusted to count the lower energy beta particles from ^{249}Bk. The alpha count rate will increase first as ^{249}Cf passes from the column; then the beta count rate increases, indicating that ^{249}Bk is being eluted. At this point, the operator can make a cut in the separation process. 4 figs.

31278 (DESY-F21–90-01) **Properties of a lead and copper calorimeter in liquid argon for measuring high energy jets with special regard to reducing shower fluctuations.** Marks, J. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Physik. Jan 1990. 130p. (In German). Order Number DE90784945. Available from NTIS (US Sales Only), PC A07/MF A01.

In the course of the development of the liquid argon calorimeter of the H1 experiment, measurements have been performed using electron and pion beams in the energy range of 30 to 230 GeV. The test calorimeter consisted of an electromagnetic section (Pb absorber) corresponding to 26 X_0 (1.1 λ) and a hadronic section (Cu absorber) corresponding to 6.1 λ. In analogy to the situation in the H1 experiment, an iron streamer tube calorimeter corresponding to 4.3 λ was placed behind the test setup. The properties of electromagnetic and hadronic showers in the liquid argon calorimeter are discussed and compared with Monte Carlo predictions (GHEISHA, version 8). Special consideration is given to reducing the fluctuations of the π^0-energy in hadronic showers on an 'event by event' basis. A nonlinear calibration function parametrized with the energy of the primary pion leads to the ratio of the response of electrons to that of pions being equal to one and therefore to a significantly improved energy resolution for pions. The energy resolution is determined and the spatial resolution for incident pions is measured. (orig./HP).

31279 (EUR–12060) **European correlation counter (ECC) VER. 1.0. users manual.** Vocino, V. (Commission of the European Communities, Ispra (IT). Joint Resarch Centre); Orazi, E. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 58p. Available from NTIS (US Sales Only), PC A04/MF A01.

The users manual is conceived for the utilization of personal computers linked to a shift register for the assay of Pu containing fuel. It is based on an MS DOS system and permits the users to store calibration curves, constants, measurement and assay data on floppy disks for ulterior utilisation. The interpretation models use the latest theories of neutron multiplication and dead time effects. The inspector is guided by the screen display step by step from the instrument test via calibration to the assay and data storage. All test, calibration and assay data can be printed out on paper tape and serve to the inspector to prepare the respective inspection report. The users are invited to make suggestions to the authors, such that the manual's use can be adapted to further requirements.

31280 (INDC(EGY)–005/L) **Research performed at the ET-RR-1 reactor using the neutron scattering equipment.** Adib, M. (Nuclear Research Centre, Cairo (Egypt). Reactor and Neutron Physics Dept.); Maayouf, R.M.A.; Abdel-Kawy, A. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Feb 1990. 23p. Project EGY/1/11/10. Order Number DE90626951. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report represents the results of studies and measurements, performed at the ET-RR-1 reactor, using the neutron scattering equipment supplied by the IAEA according to the technical assistance project EGY/1/11/10. The results of these studies, starting in 1980 and continuing to date, are discussed; the use of the equipment, both as a neutron monochromator and fixed scattering angle spectrometer, is also assessed. (author). 19 refs, 17 figs.

31281 (INP–1344/PS, pp. 328-330) **The vertical drift chamber as a two dimensional focal plane detector for light and heavy ions in a QMG/2 spectrometer.** Schippers, J.M. (Rijksuniversiteit Groningen (Netherlands). Kernfysisch Versneller Inst.); Borghols, W.T.A.; Werf, S.Y. van der. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The design and performance of a vertical drift chamber as a new two dimensional focal plane detector which has a very small contribution to the energy resolution and which can be used for the detection of various particles at different energies are presented. 3 refs., 4 figs. (M.F.W.).

31282 (Juel–2311) **Studies of low-temperature bolometers as particle detectors.** Woiwod, S. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Schicht- und Ionentechnik; Koeln Univ. (Germany, F.R.). Sep 1989. 81p. (In German). Order Number DE90785112. Available from NTIS (US Sales Only), PC A05/MF A01.

Recent results with bolometers as high resolution photon detectors raise hope of greatly improved energy resolutions in the detection of α-particles and other ions. Theoretically the conversion noise due to fluctuations in the energy stored in the created defects sets a resolution limit for thermal charged particle detection. A resolution of some hundred eV should be possible, which would offer a valuable improvement of the depth and mass resolution in RBS analysis. For this purpose we tested composite silicon bolometers with and without thin metal absorbers (Cu, Al) at temperatures between 280 and 600 mK. The particles detected by the bolometers were backscattered from a Ta-Cr-Si-sample at 1 K inside the cryostat irradiated by 200 keV ions (H, He, B). Specific problems of RBS measurements with bolometers are reviewed. The measured energy resolution of 8.0 keV FWHM for He ions is

more than a factor of 3 better than previous reported bolometric measurements on α-particles. For protons and boron ions, which were measured for the first time with a bolometer, we achieved similar good resolutions. The energy resolution deteriorates with increasing particle energy and increasing atomic number of the analyzing ion. The measured thermal noise contribution of 2 keV FWHM indicates the possibility of a further reduction of the detector resolution. Possible origins in the difference between the bolometer resolutions and the thermal noise are discussed. The investigated bolometers were characterized by resistance versus temperature measurements, load curve measurements, noise analysis and bolometer pulse analysis. The measured energy responsivities were in the order of 10^{10} V/J, which is high enough to achieve resolutions of 1 keV FWHM on principle. (orig.).

31283 (K/QT–238) **An evaluation of improvement concepts for a prototype polarographic vent monitor used for trace uranium detection.** Branam, D.A.; Powell, M.R. Oak Ridge Gaseous Diffusion Plant, TN (USA). Dec 1988. 23p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE90010892. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A prototype on-line polarographic uranium and technetium monitor was developed for use as a vent monitor for the Oak Ridge Gaseous Diffusion Plant (ORGDP) purge cascade. However, the cascade at ORGDP was shut down before the monitor could be field tested. A decision was therefore made to convert the monitor to a uranium-only monitor and to field test it at the Paducah Gaseous Diffusion Plant (PGDP) during late 1986 and 1987. During the field tests, four improvement concepts were identified as having the potential of leading to a simpler, more reliable, and for more sensitive monitor better suited for use on the PGDP purge cascade vent. The monitor was returned to ORGDP to evaluate these concepts and also to provide an opportunity to seek a solution to a recurring computer communications problem that was preventing reliable long-term operation of the monitor. The four concepts evaluated were (1) upgrading the computer system; (2) adopting a different, more sensitive, analysis method; (3) using a nebulizer to sample deoxygenation; and (4) using a nebulizer for sample collection. As a result of these evaluations, several improvements were identified that will be incorporated into the next generation polarographic vent monitor. These improvements incorporated into the next generation polarographic vent monitor. These improvements include: (1) using and IBM-XT computer and a Keithley 570 data acquisition and control system to operate the monitor, (2) using an analysis method which lowers the detection limit by providing faster of 1000 over the method originally used, and (3) reducing the analysis cycle time by providing faster deoxygenation through use of the nebulizer. Collection of samples through use of the nebulizer was proven to be feasible. However, this concept will need further evaluation to determine if it would be superior to the existing scrubbing technique in the PGDP application. 2 refs., 6 figs.

31284 (MPI-PAE/Exp.El.–217) **Double sided silicon strip detectors.** Bauer, C.; Becker, H.; Boulos, T.; Cattaneo, P.; Dietl, H.; Hauff, D.; Holl, P.; Lange, E.; Lutz, G.; Moser, H.G. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Jan 1990. 20p. Available from Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.

A new type of double sided silicon strip detectors has been built that incorporates capacitive coupling of the strips to the readout electronics by integrating the capacitors into the detector design, made possible by introducing a new detector biasing concept. The detectors are read out using custom designed low noise VLSI CMOS electronics mounted on ceramic carriers which simultaneously serve as mechanical support and substrates for thick film hybrid circuitry. Prototype detectors have been installed in the ALEPH detector at the e^+e^- collider LEP at CERN and hits from hadronic Z^0 decays have been observed on both sides of the detectors. This report is a compilation of three articles on the design and tests of these devices that have been prepared for the IEEE transactions on Nuclear Science in 1988 and 1989. (orig.).

31285 (NRPB-R–230) **Calibration of photon personal dosemeters in terms of the ICRU operational quantities: calculations of phantom backscatter and depth-dose distributions.** Dimbylow, P.J.; Francis, T.M.; Bartlett, D.T. National Radiological Protection Board, Chilton (UK). Jan 1990. 90p. Available from H.M. Stationery Office, London, price Pound 7.00.

Calculations have been performed of the dose equivalent distributions inside, and the energy and angle spectral distributions of the backscattered radiation field at and near the surface of, some phantoms of interest for the calibration of personal dosemeters for the measurement of incident photon radiation. The results, which were obtained for incident photon energies of 15, 25, 50, 75, 100, 150 and 662 keV, have been interpolated to some values of the ISO narrow series of reference fluorescence X-radiation and folded with calculated spectra to obtain values for the ISO narrow series of reference filtered X-radiation. The results are considered in the context of approaches to the calibration of personal dosemeters for the measurement of the new ICRU operational quantities. (author).

31286 (ORNL/FTR–3589) **[Concepts for future developments in electron microscopy]: Foreign trip report, March 24, 1990–March 31, 1990.** Allard, L.F.; Nolan, T.A. Oak Ridge National Lab., TN (USA). 30 Apr 1990. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010630. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

At the request of Hitachi, Ltd. and JEOL, Ltd. and primarily at their expense, the travelers visited the JEOL factory and the Hitachi Central Research Laboratory in Tokyo, and the Hitachi Naka Works Factory in Katsuta. At these three facilities the travelers presented seminars explaining both ORNL's significance in materials research and electron microscopy and concepts relating to transmission electron microscopy resolution improvements, instruments and concepts that the manufacturers are developing. Additionally, they had the opportunity to assess the performance of the recently introduced Hitachi 200-kV Field Emission Gun TEM. The visit provided the travelers a unique opportunity to influence the directions for future instrumental developments by two major electron microscope manufacturers.

31287 (ORNL/FTR–3590) **[Discussions on the design of the data triggering and analysis system for the SSC L-Star detector]: Foreign trip report, March 27–April 5, 1990.** Bauer, M. Oak Ridge National Lab., TN (USA). 19 Apr 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010110. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Collaborators on the L-Star detector system met to discuss the design of a data triggering and acquisition system and to assign responsibilities for writing the expression of interest (EOI) for the SSC Laboratory. In addition, areas for future work were delineated. The trip was successful in that ORNL was assigned responsibility for writing half of the trigger and data acquisition chapter for the EOI. We also enhanced our position as designers of the front-end electronics for all detector subsystems for the L-Star detector. The traveler presented an informal review of ORNL efforts in application-specific electronics and computing architectures.

31288 (ORNL/FTR–3598) **[Participation in the L* calorimeter working group]: Foreign trip report, March 24–April 17, 1990.** Plasil, F. Oak Ridge National Lab., TN (USA). 25 Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010556. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the L* calorimeter working group held at CERN, Geneva, Switzerland, March 25–28, 1990. Significant progress was made toward defining the calorimeter options to be featured in the L* expression of interest (EOI). The traveler participated in the L* working group on triggers and data acquisition held in Rome, Italy, March 28–31, 1990. This area of the L* proposal will require considerable work, both for the EOI and for the final written proposal. The traveler attended the International Workshop on Nuclear Dynamics held at Marciana Marina, Island of Elba, Italy, April 1–7, 1990, and presented an invited paper entitled "Nucleus–Nucleus Collisions at 200 GeV/Nucleon: Results from CERN WA80 Experiment." The traveler also presented a series of

lectures on experiments with relativistic heavy ions at the University of Catania, Italy, April 9–11.

31289 (PB–90-177007/XAB) **Single-sphere multiple-detector neutron spectrometer. Final report on Phase 1.** Sinclair, F.; Stern, I.; Hahn, R.W.; Entine, G. Radiation Monitoring Devices, Inc., Watertown, MA (USA). Jul 1987. 33p. Available from NTIS, PC A03/MF A01.

To address the problem of accurate, timely estimates of the neutron spectral flux, researchers are developing a monitoring instrument based on a single moderating sphere with a large number of independent sensors. Such a single-sphere spectrometer would allow easy measurement of quality factors. This is made possible by the recent development of a novel digital sensor which detects radiation induced errors in a dynamic random-access memory. During Phase I of the SBIR program, researchers constructed a first prototype of the single-sphere spectrometer, measured its response in a neutron flux from an isotopic Am-Be source in several geometries, and compared these with the results of Monte Carlo simulations of neutron transport. The preliminary results show that the approach is feasible and relatively straightforward.

31290 (RAL–90-001) **The UA1 upgrade calorimeter trigger processor.** Bains, N. (Birmingham Univ. (UK)); Baird, S.A.; Biddulph, P. Rutherford Appleton Lab., Chilton (UK). Jan 1990. 44p. Order Number DE90626965. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The increased luminosity of the improved CERN Collider and the more subtle signals of second-generation collider physics demand increasingly sophisticated triggering. We have built a new first-level trigger processor designed to use the excellent granularity of the UA1 upgrade calorimeter. This device is entirely digital and handles events in 1.5 μs, thus introducing no deadtime. Its most novel feature is fast two-dimensional electromagnetic cluster-finding with the possibility of demanding an isolated shower of limited penetration. The processor allows multiple combinations of triggers on electromagnetic showers, hadronic jets and energy sums, including a total-energy veto of multiple interactions and a full vector sum of missing transverse energy. This hard-wired processor is about five times more powerful than its predecessor, and makes extensive use of pipelining techniques. It was used extensively in the 1988 and 1989 runs of the CERN Collider. (author).

31291 (SAND–85-0699) **X-Ray Detector: An x-ray radiation detector design code.** Spielman, R.B. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 38p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008235. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

X-Ray Detector (XRD) is an x-ray detector design code. It is intended to aid in the rapid design of x-ray detector packages. The design capabilities of XRD include filters, x-ray mirrors, x-ray diodes, silicon PIN diodes, GaAs PIN diodes, photoconducting detectors, bolometers, and x-ray film. XRD uses x-ray cross-section information stored in easily-modified external libraries. Interactive calculations are completed in seconds using a DEC VAX 8650. Some of the more notable features of XRD are edge handling in the x-ray photoelectric cross-section data, I/O error handling, internal error messages, nearly bomb-proof design, and extensive documentation. 7 refs., 7 figs.

31292 (SLAC-PUB–5207) **Aging of gaseous detectors.** Va'Vra, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9003150–1: 5. international conference on instrumentation for colliding beam physics, Novosibirsk (USSR), 15-21 Mar 1990). Order Number DE90010178. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper makes an overview of developments in the wire chamber aging field since the wire chamber aging workshop held at the Lawrence Berkeley Laboratory, Berkeley, California on January 16–17, 1986. The author discusses new techniques to analyze the gas impurities and the wire aging products, wire "nonaging" in clean systems, wire aging in systems containing various impurities, various examples of problems which can "prime" surfaces prior to the occurrence of the aging, and some recent aging experience with the "SSC micro-straw tubes." 35 refs., 10 figs., 2 tabs.

31293 **Spectrochemical analysis by multiphoton ionization in a low pressure sampling interface.** Ramsey, J.M. (Oak Ridge National Lab., TN (USA)); Whitten, W.B.; Blazewicz, P.R. vp.. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 019.

The authors are investigating different approaches for performing spectrochemical analysis at very high resolution. The goal is to achieve reliable isotopic information. conventional atomic sources that utilize continuous sample introduction operate at high temperatures and atmospheric pressures. These conditions lead to extreme spectral line broadening due to Doppler and collisional effects. These line broadening effects must be overcome before spectroscopy can be performed at the natural line width limit. Collisional broadening is made insignificant by extracting the species of interest from the high temperature/high pressure source into a low pressure environment through a sampling orifice. The low pressure region is evacuated to 1 torr or less reducing the collisional broadening to less than 10 MHz. The effects of Doppler broadening can be overcome by applying nonlinear spectroscopic techniques. In this paper the authors discuss the use of two photon resonance enhanced photoionization. The use of counterpropagating laser beams yields a Doppler free signal for the two photon resonance. Studies employing an air/acetylene flame are discussed. Neutral atoms produced in the flame from aspirated solutions and molecular species produced in the combustion process are detected. Detection limits near 1 part per trillion have been demonstrated for sodium lithium and copper.

31294 **Soft x-ray streak cameras.** Stradling, G.L. (Los Alamos National Lab., Physics Div., Los Alamos, NM (US)). pp. 1063 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808103–: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

This paper is a discussion of the development and of the current state of the art in picosecond soft x-ray streak camera technology. Accomplishments from a number of institutions are discussed. X-ray streak cameras vary from standard visible streak camera designs in the use of an x-ray transmitting window and an x-ray sensitive photocathode. The spectral sensitivity range of these instruments includes portions of the near UV and extends from the subkilovolt x- ray region to several tens of kilovolts. Attendant challenges encountered in the design and use of x-ray streak cameras include the accommodation of high-voltage and vacuum requirements, as well as manipulation of a photocathode structure which is often fragile. The x-ray transmitting window is generally too fragile to withstand atmospheric pressure, necessitating active vacuum pumping and a vacuum line of sight to the x-ray signal source. Because of the difficulty of manipulating x-ray beams with conventional optics, as is done with visible light, the size of the photocathode sensing area, access to the front of the tube, the ability to insert the streak tube into a vacuum chamber and the capability to trigger the sweep with very short internal delay times are issues uniquely relevant to x-ray streak camera use. The physics of electron imaging may place more stringent limitations on the temporal and spatial resolution obtainable with x-ray photocathodes than with the visible counterpart. Other issues which are common to the entire streak camera community also concern the x-ray streak camera users and manufacturers.

31295 **Material parameters in a thick hydrogenated amorphous silicon detector and their effect on signal collection.** Qureshi, S. (Lawrence Berkeley Lab., Berkeley, CA (US)); Perez-Mendez, V.; Kaplan, S.N.; Fujieda, I.; Cho, G. pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-890426–: Spring

meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

Transient photoconductivity and ESR measurements were done to relate the ionized dangling bond density and the spin density of thick hydrogenated amorphous silicon (a-Si:H) detectors. The authors found that only a fraction (~30-35%) of the total defect density as measured by ESR is ionized when the detector is biased into deep depletion. The measurements on annealed samples also show that this fraction is about 0.3. An explanation based on the shift of the Fermi energy is given. The measurements show that the time dependence of relaxation is a stretched exponential.

31296 The application of thick hydrogenated amorphous silicon layers to charged particle and x-ray detection. Perez-Mendez, V. (Lawrence Berkeley Lab., Berkeley, CA (US)); Cho, G.; Fujieda, I.; Kaplan, S.N.; Qureshi, S.; Street, R.A. pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC03-76SF00098. (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

The authors outline the characteristics of thick hydrogenated amorphous silicon layers which are optimized for the detection of charged particles, x-rays and γ-rays. Signal amplitude as a function of the linear energy transfer of various particles are given. Noise sources generated by the detector material and by the thin film electronics - a-Si-H or polysilicon proposed for pixel position sensitive detectors readout are described, and their relative amplitudes are calculated. Temperature and neutron radiation effects on leakage currents and the corresponding noise changes are presented.

31297 A new type of multiparticle imaging detector. Belkacem, A. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Faibis, A.; Kanter, E.P.; Koenig, W.; Mitchell, R.E.; Vager, Z.; Zabransky, B.J. *Review of Scientific Instruments (USA)*, 61(3): 945-952 (Mar 1990).

The foil-induced dissociation of molecular ions can provide a direct image of the stereochemical structures of small molecules. Such experiments require high-resolution measurements of the relative momenta of all dissociation fragments. In order to improve and extend previous studies of this type to a larger variety of molecules and clusters, we have developed a new type of low-pressure multiwire proportional counter. The novel feature of this large-area (25×50 cm^2) multiparticle detector is that all the signals are recorded from a single two-level printed circuit board which serves as the anode. This segmented anode consists of three families of nonintersecting "wires" which are interwoven on the rear surface of the board. By redundantly determining positions and arrival times, the new segmented anode multiparticle detector provides good time resolution (100–200 ps) and high spatial resolution (0.2 mm) for detecting as many as six simultaneous particles.

31298 Cavity design for a cosmic axion detector. Hagmann, C. (Physics Department, University of Florida, Gainesville, Florida 32611 (US)); Sikivie, P.; Sullivan, N.; Tanner, D.B.; Cho, S. *Review of Scientific Instruments (USA)*, 61(3): 1076-1085 (Mar 1990).

We discuss cavity tuning schemes for cosmic axion searches and strategies to extend such searches to high frequency without sacrifice in volume and hence signal-to-noise. Particular regard is given to the difficulties that arise from the tendency of the cavity mode to localize in a small region of the cavity and from the fact that the modes may become relatively dense in frequency space. Computer simulations of cavity performance have been carried out in order to optimize the cosmic axion search rate for a given magnet size and field.

31299 Monte Carlo calculations of the vacuum Compton detector sensitivities. Hsu, H.H. (Univ. of California, Los Alamos National Lab, Los Alamos, NM (US)); Lee, H. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1926-1930 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

Monte Carlo simulations have been carried out to compute the static sensitivity of the vacuum Compton detector for monoenergetic gamma rays and electrons. A similar calculation using ^{60}Co spectrum as input is found in good agreement with measurements. The authors also calculate the detector sensitivities for bremsstrahlung spectra produced by monoenergetic e-beams and compare with experimental data.

31300 Comparison of experimental pulse-height distributions in germanium detectors with integrated-tiger-series-code predictions. Beutler, D.E. (Sandia National Lab., Albuquerque, NM (US)); Halbleib, J.A.; Knott, D.P. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1912-1919 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports pulse-height distributions in two different types of Ge detectors measured for a variety of medium-energy x-ray bremsstrahlung spectra. These measurements have been compared to predictions using the integrated tiger series (ITS) Monte Carlo electron/photon transport code. In general, the authors find excellent agreement between experiments and predictions using no free parameters. These results demonstrate that the ITS codes can predict the combined bremsstrahlung production and energy deposition with good precision (within measurement uncertainties). The one region of disagreement observed occurs for low-energy (<50 keV) photons using low-energy bremsstrahlung spectra. In this case the ITS codes appear to underestimate the produced and/or absorbed radiation by almost an order of magnitude.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to citation(s) 31223, 31296, 31299

31301 (SAND–89-2956) **Magnetic-field shielding of satellites from high-energy-electron environments.** Vittitoe, C.N. Sandia National Labs., Albuquerque, NM (USA). May 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010296. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Magnet configurations are found that limit the 6-MeV electrons threatening satellite electronics to <1% of the incident flux. Successful configurations of permanent magnets and electromagnets require magnetic energies of ~8 to 12 kJ to protect each liter of electronics volume. The fundamental strength of materials leads to a required minimum mass of ~48 to 64 kg/liter to support the magnetic pressure. With the electronics requiring ~5 liters, several hundred kilograms are needed for this support. Except for protecting small apertures, magnetic shielding provides little, if any, advantage over that obtained by coating with an equivalent mass using traditional methods. 7 refs., 9 figs., 1 tab.

31302 Effects of x-rays on optical materials and coatings. Rathkopf, J.A. (Lawrence Livermore National Lab., CA (USA)); White, R.H. pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

Analyses of optical components consisting of a metal reflecting layer, a beryllium energy-sharing layer, and a fused silica substrate were done using LXRT, a version of the XRT computer code. These are compared with calculations for components lacking the beryllium layer. The authors analyses show that the addition of the beryllium significantly hardens the system against x-rays. The mechanisms for this increased hardness are apparent from time-dependent temperature and enthalpy plots presented in this paper.

31303 Comparison of MOS capacitor and transistor postirradiation response. McWhorter, P.J. (Sandia National Labs., Alburquerque, NM (US)); Fleetwood, D.M.; Pastorek, R.A.; Zimmerman, G.T. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1792-1799 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The postirradiation response of MOS capacitors and transistors fabricated on the same chip has been examined as a function of dose and anneal bias. A variety of analysis techniques are used to evaluate the postirradiation response of these structures, including low and high frequency capacitance-voltage techniques, subthreshold current-voltage techniques, and charge pumping. Though there are changes in the postirradiation energy spectrum of ΔD_{it}, no clear evidence of defect transformation is observed on transistors or capacitors under any conditions examined. Postirradiation response at 80°C is found to be similar in the two structures for low levels of damage (100 krad). For both structures, interface-trap densities continue to grow following irradiation under these conditions. In contrast, the postirradiation response of capacitors and transistors can differ qualitatively at higher levels of damage (1 Mrad), with interface-traps increasing postirradiation at 80°C for transistors and annealing for capacitors. These results indicate that capacitor structures may not be suitable for hardness assurance studies that involve elevated temperature irradiations or postirradiation anneals.

31304 Theory and application of dual-transistor charge separation analysis. Fleetwood, D.M. (Sandia National Labs, Alburquerque, NM (US)); Schwank, J.R.; Winokur, P.S.; Sexton, F.W.; Shaneyfelt, M.R. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36: 1816-1824 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The authors describe a dual-transistor charge separation method to evaluate the radiation response of MOS transistors. This method requires that n- and p-channel transistors with identically processed oxides be irradiated under identical conditions at the same oxide electric fields. Combining features of single-transistor midgap and mobility methods, the authors show how one may determine threshold voltage shifts due to oxide-trapped and interface-trapped charge from standard threshold voltage and mobility measurements. These measurements can be made at currents 2-5 orders of magnitude higher than those required for midgap, subthreshold slope, and charge-pumping methods. The dual-transistor method contains no adjustable parameters, and includes an internal self-consistency check. The accuracy of the method is verified by comparison to midgap, subthreshold slope, and charge-pumping methods for several MOS processes and technologies.

31305 Energy dependence of neutron damage in silicon bipolar transistors. Sparks, M.H. (Nuclear Effects Lab., White Sands Missile Range (US)); Flanders, T.M.; Sallee, W.W.; Meason, J.L.; Williams, J.G.; Kelly, J.G.; Roknizadeh, M. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 1904-1911 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports on 2N222A transistors exposed in various neutron fields ranging in energy from thermal to 14 MeV. New spectrum characterization data are reported for three fast reactors used in hardness testing. The neutron energy dependence of transistor damage response was measured and compared with predictions based on ASTM Standards and recent compilations of the silicon kerma factors calculated using NJOY.

31306 Strategies for lot acceptance testing using CMOS transistors and ICS. Schwank, J.R. (Sandia National Labs., Albuquerque, NM (US)); Sexton, F.W.; Fleetwood, D.M.; Rodgers, M.S.; Shaneyfelt, M.R.; Hughes, K.L. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 1971-1980 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

Direct correlation and simple overstress methods to estimate IC response in strategic and space environments from laboratory transistor and IC data are investigated. Transistors and ICs were irradiated at dose rates from 0.2 rad(SiO_2)/s to 106 rad(SiO_2)/s. Laboratory transistor and IC data are compared to IC data taken at high and low dose rates. Over a wide range of process conditions and hardness levels, laboratory measurements of δVot correlate well with IC leakage current at high dose rates for ICs with gate-oxide dominated response. For ICs whose response is dominated by parasitic field oxide structures, laboratory measurements of both transistor and IC leakage currents correlate well with IC hardness at high dose rates. For dose levels up to $\simeq$500 krad(SiO_2), it is shown that a simple factor-of-3 overtest can be used as a conservative estimate of radiation hardness of these technologies for strategic applications, provided that both functional and parametric testing is performed following x-ray irradiations at a dose rate of $\simeq$ 2000 rad(SiO_2)/s. For space environments, a laboratory irradiation to 1.5-times the required system level followed by a one week 100°C biased anneal gave conservative estimates of IC hardness.

31307 Neutron effects in high-power GaAs laser diodes. Carson, R.F. (Sandia National Lab., Albuquerque, NM (US)); Chow, W.W. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2076-2082 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports how the lasting threshold currents of high-power GaAs laser diodes and arrays increased less than 40% after exposure to 10^{14} n/cm^2. Threshold current rose by 100 to 250% and a possible increased susceptibility to facet damage was observed at 10^{15} n/cm^2.

31308 Radiation characterization of a C256 EEPROM. Wrobel, T.F. (Sandia National Labs., Albuquerque, NM (US)). *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2247-2251 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

Total dose, dose-rate and high dose-rate memory retention results are presented for the SEEQ Technologies Inc., 28C256 floating gate electrically erasable programmable read only memory (EEPROM). Total dose failure levels are mode dependent, i.e. ~33 krad(Si) for reading and ~9.5 krad(Si) for writing. The write-mode failure level is dose-rated dependent, increasing from ~10 krad(Si) at ~11 rad(Si)/s to ~ 28 krad(Si) at dose rates ~0,1 rad(Si)/s Average upset and latch-up thresholds are 3.8×10^8 rad(Si)/s and 7.7×10^8 rad(Si)/s respectively. No latch-up windows were observed. Memory contents were retained following exposure up to 108 krad (Si) and following 1×10^{12} rad(Si)/s.

31309 A radiation-hardened 16/32-bit microprocessor. Hass, K.J. (Sandia National Labs., Albuquerque, NM (US)); Treece, R.K.; Giddings, A.E. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2252-2257 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports on the development of single chip radiation-hardened 16/32-bit microprocessor. This device, the SA3300, is an emulation of National Semiconductor's NS32C016. The SA3300 is designed to withstand high levels of ionizing radiation and is resistant to single event upset (SEU) caused by heavy ions. New techniques were used to improve immunity to SEU effects in combinational logic. The authors' testing has demonstrated that the SA3300 is functional after a total gamma dose of 5 Mrad(Si). The device does not latch up from SEU, and parts without SEU resistors have an SEU linear energy transfer (LET) upset threshold greater than 28 MeV/mg/cm^2.

31310 SEU characterization of a hardened CMOS 64K and 256K SRAM. Sexton, F.W. (Sandia National Lab., Albuquerque, NM (US)); Fu, J.S.; Kohler, R.A.; Koga, R. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2311-2317 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports on single-event-upset (SEU) tests of the AT and T 64K and 256K SRAMs. Feedback resistor values for these parts ranged from 200kΩ to 1MΩ. All were fabricated using the 1-μm 2-level poly, 2-level metal process. Ions used for these tests

were Ar, Cu, Kr, and Xe providing a range of effective LET values from 20 to 129 MeV-cm^2/mg. With the 64K SRAM operating at 4.5 volts and 90°C, and upset threshold LET of 30 MeV-cm^2/mg and saturation cross-section of 1.5×10^{-2} cm^2 were measured with a nominal room temperature feedback resistance of 450kΩ. In Adam's 10% worst-case environment using the Petersen approximation, this implies an error rate of 1.3×10^{-7} errors per bit-day. With a nominal 650kΩ feedback resistance, a 256K SRAM had a calculated error rate of about 3×10^{-8} errors per bit-day at 4.5 volts and 90°C. This data agree well with earlier data for a 1K-bit test chip. The minimal feedback resistance required to prevent upset vs. LET is calculated by assuming an activation energy of 0.10 eV to estimate the decrease in feedback resistor value as a function of temperature.

31311 Co-60 and neutron irradiation of MOS-controlled thyristors. Loescher, D.H. (Sandia National Labs., Albuquerque, NM (US)); Dawes, W.R. Jr.; King, D.B. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 2411-2414 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports changes MOS-Controlled Thyristor (MCT) performance caused by irradiation with fast neutrons (E>1 MeV) and with Co-60 gamma rays. The results are significant because the MCT is representative of a growing class of power devices that combine bipolar and field effect transistor (FET) technologies and because MCTs are being considered for use in systems that must survive exposure to radiation. The MCTs tested, which were designed to hold off 400 volts and carry 50 amperes, were operable with ±10 volt control voltages after they received a total dose of 1 Mrad(Si), but could not be turned on after exposure to 1E12 n/cm^2.

4404 Well Logging Instrumentation

Refer also to citation(s) 30272, 31420, 31673

4405 Thermal Instrumentation

Refer also to citation(s) 30599

4406 Optical Instrumentation

Refer also to citation(s) 30833, 30911, 30951, 31001, 31006, 31302, 31685, 32031

31312 (EGG-M–89048) **A convenient system for the manufacture of holographic diffraction gratings.** Deason, V.A.; Ward, M.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8908222–2: 3. international conference on laser interferometry, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90009481. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A device that provides a very convenient facility for the manufacture of holographic diffraction gratings is described. The system employs single mode polarization maintaining optical fibers and a simple opto-mechanical design to permit great flexibility in grating manufacture. The intended application of these gratings is diffraction moire interferometry. A variety of gratings ranging from less than 100 to more than 2000 1/mm can be made with minimal time required for changing between grating frequencies. Furthermore, the rational design of the device permits one to easily generate more complex gratings, including crossed gratings, gratings having two or more superimposed groove spatial frequencies, or gratings having other unusual features such as induced aberrations. 4 refs., 4 figs.

31313 (LA-UR–90-1434) **A low-cost infrared telemetry system for kilohertz-bandwidth data acquisition.** Holder, M.D. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9003149–2: 3. test technology symposium, Laurel, MD (USA), 19-21 Mar 1990). Order Number DE90010616. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A telemetry system is described that transmits data from three 8-kHz analog inputs by means of an infrared-optical-digital communications channel. This system is used to acquire accelerometer data on a rocket sled during its 300-m flight. An optical communications channel at 950 nm is used to send digitally encoded analog signals from the sled to a fixed receiver. The signal is recorded and decoded by a computer. The transmitter includes a differential amplifier and low-pass filter for each input channel. Excitation for piezoresistive accelerometers is also provided. Each input channel is sampled and digitized at a 16-kHz rate. The transmitter is built on a single printed-circuit card measuring 7.5 cm by 23 cm, weighing less than 450 g including batteries. This system can be used on tests involving destruction of the transmitter because of its low cost. 7 figs.

31314 (MLM–3633(OP)) **PC-based digital imaging for storing microscopy images for surveillance programs.** Schleitweiler, P.M.; Ransick, M.H. EG and G Mound Applied Technologies, Miamisburg, OH (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. (CONF-9004146–8: 16. DOE compatibility, aging and service life conference, Livermore, CA (USA), 24-26 Apr 1990). Order Number DE90010080. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Advances in video technology and digital imaging have resulted in the ability to produce an image in high quality digital format. Images that are created and viewed in a digital format can be quantitatively measured and then stored to disk for later examination. Write-once read many (WORM) optical disks are excellent media for permanently archiving digital images. One of the best applications for this image storage technology is storage of microscopy images for surveillance programs. Currently, the most common type of recording medium used in service laboratories is Polaroid instant developing film. The short developing time and ease in processing make it swell suited for most high volume laboratories. But the convenience of this film has a substantial price tag. Depending on the type of film, each picture can cost about $1.50. The two metallurgical support laboratories at Mound are frequently required to make multiple copies for design agencies or program managers. Permanent archiving of photos is required for both WR and surveillance samples. This has made Polaroid film a significant part of the expense budget. In addition, the thousands of photos taken annually present a considerable storage problem. 2 figs.

31315 Specification and testing facilities for optical components used in a high average power visible laser system. Taylor, J.R. (Lawrence Livermore National Lab., CA (USA)). pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

Optical component specifications for high average power laser systems must address performance, efficiency, maintainability, and reliability. The requirements for high performance optics goes beyond conventional methods of specification. Methods of specification for this application are discussed in addition to several areas that need attention within the optics community. The specifications must be based upon the available methods of testing. The ability to test the optical components is crucial to both successful manufacturing and system operation. This means that both the manufacturer and uses must have testing capability. For large system applications, the test facility must be designed to meet the demand of a high volume of optics as well as measurement precision The facility for testing these parts is described for an application requiring thousands of optical components. This test capability is also an important part of system design and development when the performance of high performance optics can be defined and incorporated during planning for a large facility.

31316 Experimental investigations of Smith–Purcell radiation. Shih, I. (Hughes Aircraft Company, Support Systems, P.O. Box 9399, Long Beach, California 90810-0399 (US)); Chang, D.; Drummond, J.; Dubbs, K.; Masters, D.; Prohaska, R.; Salisbury, W.

Journal of the Optical Society of America, Part B: Optical Physics (USA), 7(3): 351-356 (Mar 1990). DOE Contract FG03-85ER13448.

We present experimental investigations of Smith–Purcell radiation and Salisbury's model and emphasize the amplification mechanism and efforts to build a resonator operating in the visible wavelength region. The first experiment demonstrated that electrons can be reflected from a rough surface owing to crystal-lattice diffraction. The second experiment showed that the radiation output increases exponentially as the beam thickness increases, indicating a possible occurrence of lasing action; the results were consistent with Salisbury's model. The last experiment yielded inconclusive results; the use of a more stable electron beam and a blazed grating is suggested for future experiments.

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 31363

4408 Miscellaneous Instrumentation

Refer also to citation(s) 30022, 30072, 30084, 30297, 30639, 30900, 30902, 30905, 30906

31317 (AD-A–217095/9/XAB) **Variable-temperature scanning tunneling microscopy. Final report, 1 August 1988-31 December 1989.** Lyding, J.W. Illinois Univ., Urbana, IL (USA). Dept. of Electrical and Computer Engineering. 8 Jan 1990. 20p. (UILU-ENG–90-2538). Available from NTIS, PC A03/MF A01.

Variable temperature STM/STS experiments have been performed over the 4.2 K to 400 K temperature range using a patented STM design. These experiments have been performed on semiconductors, superconductors, charge-density wave (CDW) systems, surfaces modified by the STM, and DNA. Low temperature spectroscopy has been used to study energy gap formation using superconducting probes and samples, and to study the coulomb staircase associated with single electron charging effects. Semiconductor studies are now directed at the creation of a Si-MOSFET in which the STM is used to pattern the gate region on a scale small enough for device operation to be dominated by quantum effects at high temperatures. Surface modifications of graphite using the STM are related to this effort. Low temperature spectroscopy is also being evaluated as a means of sequencing single strand DNA molecules. Individual, short DNA molecules supported on graphite are readily observed at low temperatures (< 50 K) but are too mobile for room temperature studies.

31318 (CONF-9005123–1) **Remote monitoring of incinerator emissions using FTIR [Fourier transform infrared spectroscopy].** Demirgian, J.C.; Spurgash, S. Argonne National Lab., IL (USA). [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 9. annual international symposium on the incineration of radioactive, hazardous, mixed and medical wastes: incineration conference '90; San Diego, CA (USA); 14-18 May 1990. Order Number DE90009709. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Remote Fourier transform infrared spectroscopy (FTIR) instrumentation has the potential to monitor incinerator emissions. The objective of this work was to demonstrate the feasibility of using remote FTIR as an incinerator monitor. Initial FTIR data were collected for chloroform and carbon tetrachloride. The sensitivity of the equipment is currently in the low ppM region for a 1-m pathlength. Remote FTIR was able to identify and quantify components with overlapping absorbances in the presence of interference from carbon dioxide. 3 refs., 5 figs., 4 tabs.

31319 (DOE/CE/15401–T7) **A miniature inexpensive, oxygen sensing element: Seventh quarterly report, 31 January 1990–30 April 1990.** Arenz, R.W. CeramPhysics, Inc., Westerville, OH (USA). 30 Apr 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE15401. Order Number DE90009938. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper is a progress report by Ceramphysics, Inc. on their efforts to design and fabricate an instrument to measure oxygen. This report discusses the project's two tasks. The first task consisted of choosing the sensor ceramics, developing the sealing techniques, and designing the heating element. The second task's objective was the preliminary fabrication of the measuring instrument. (FSD)

31320 (KFK–4688) **Parallel computation of electrostatic potentials and fields in technical geometries on SUPRENUM. EPOTZR-P and EFLDZR-P user's guide.** Alef, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik. Feb 1990. 98p. (In German). Contract BMFT ITR8502K/4. Order Number DE90784802. Available from NTIS (US Sales Only), PC A05/MF A01.

The programs EPOTZR und EFLDZR have been developed in order to compute electrostatic potentials and the corresponding fields in technical geometries (example: Diode geometry for optimum focussing of ion beams in pulsed high-current ion diodes). The Poisson equation is discretized in a two-dimensional boundary-fitted grid in the (r,z)-plane and solved using multigrid methods. The z- and r-components of the field are determined by numerical differentiation of the potential. This report contains the user's guide of the SUPRENUM versions EPOTZR-P and EFLDZR-P. (orig./HP).

31321 (SAND–90-0139C) **Multiple-frequency surface acoustic wave devices as sensors.** Ricco, A.J.; Martin, S.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006172–1: Solid state and sensor actuator workshop, Hilton Head Island, SC (USA), 4-7 Jun 1990). Order Number DE90009972. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have designed, fabricated, and tested a multiple-frequency acoustic wave (MUFAW) device on ST-cut quartz with nominal SAW (surface acoustic wave) center frequencies of 16, 40, 100, and 250 MHz. The four frequencies are obtained by patterning four sets of input and output interdigital transducers of differing periodicities on a single substrate. Such a device allows the frequency dependence of AW sensor perturbations to be examined, aiding in the elucidation of the operative interaction mechanism(s). Initial measurements of the SAW response to the vacuum deposition of a thin nickel film show the expected frequency dependence of mass sensitivity in addition to the expected frequency independence of the magnitude of the acoustoelectric effect. By measuring changes in both wave velocity and attenuation at multiple frequencies, extrinsic perturbations such as temperature and pressure changes are readily differentiated from one another and from changes in surface mass. 10 refs., 6 figs., 1 tab.

31322 (SAND–90-0206) **Operational and performance characteristics of the PCP PHEMTO-CHEM 100 ion mobility spectrometer.** Ingersoll, D.; Rodacy, P.J. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010193. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The PCP PHEMTO-CHEM 100 ion mobility spectrometer (IMS) exhibits a number of characteristics that affect its performance for the quanititative and qualitative analysis of explosives in solution and in the gas phase. These characteristics, as well as modifications to the system that will either eliminate, or reduce, the extent of some problems associated with these characteristics, are described. Also described are other aspects of the operation and performance of this system. 9 refs., 10 figs., 1 tab.

31323 **How do you assure the quality of chemical measurements when you seldom analyze the same kind of sample twice.** Pyper, J.W. (Lawrence Livermore National Lab., CA (USA)). vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 989.

For the most part, formal plans to assure the quality of chemical measurements have been implemented in laboratories that analyze samples with compositions that are predictable within specified limits. An example is a manufacturing plant that provides samples of products that are similar and for which analysis protocols can be developed. The authors have developed a formal quality assurance plan which bridges the gap between the craftsman/artisan and usual formal approaches to quality assurance. The elements of the plan include sample logging and tracking, a manual of validated methods, documentation of quality control procedures, control charting of the analyses of quality control samples for appropriate techniques and provisions for auditing the plan to insure the quality of the data. The quality assurance plan is discussed in the paper.

31324 **Recent advances in high speed photography and associated technologies in the U.S.A.** Paisley, D.L. (Los Alamos National Lab., Los Alamos, NM (US)). pp. 1063 of Proceedings of the 18th international congress on high speed photography and photonics. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808103–: 18. international congress on high-speed photography and photonics, Xian (China), 28 Aug - 2 sep 1988).

In the past decade, high speed photography has been rapidly incorporating electrooptics. More recently, optoelectronics and digital recording of images for specialized laboratory cameras and commerically available systems have helped broaden the versatility and applications of high speed photography and photonics. This paper highlights some of these technologies and specialized systems.

31325 **(110) Oriented silicon water latch accelerometer process for forming the same.** Ciarlo, D.R. To U.S. Dept. of Energy, Washington, DC. USA Patent 4891255/A/. 2 Jan 1990. Filed date 29 Sep 1988. USA Patent Application 7-250,591. Int. Cl. B32B 3/10. vp.

This patent describes an apparatus. It comprises: a (110) silicon wafer with a thickness, comprising: a frame; a first cantilever beam, with a first end attached to the frame and a second end, which is a free end which is not attached to the frame, and with a length dimension from the first end to the second end, and a thickness, wherein the length and the thickness are substantially parallel to the (110) plane, and a width substantially perpendicular to the (110) plane and substantially equal to the thickness of the wafer; a second cantilever beam, with a first end attached to the frame and a second end, which is a free end which is not attached to the frame, and with a length dimension from the first end to the second end, and a thickness, wherein the length and the thickness are substantially parallel to the (110) plane, and a width substantially perpendicular to the (110) plane and substantially equal to the thickness of the wafer, and where the length of the first cantilever forms an angle with the length of the second cantilever, where the value of the angle is substantially 70.5° or 109.5°.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 30974, 31313

31326 (LA-UR–90-1433) **Realistic warhead and blast shield testing of chemical energy tandem warhead systems for advanced antitank missiles.** Fradkin, D.B.; Hull, L.M.; Laabs, G.W. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-9003149–1: 3. test technology symposium, Laurel, MD (USA), 19-21 Mar 1990). Order Number DE90010615. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The results of dynamic sled track performance testing of advanced tandem configuration shaped-charge warheads against multiple-reactive-element tank armors are presented. Tandem configurations utilizing both currently fielded and experimental shaped-charge warheads were tested. Sled velocities used were between 400 and 1100 ft/s (Mach number 0.35 to 0.95), typical of the terminal approach velocity of TOW-type antitank missiles. High-speed motion pictures (5000 frames/s) of the sled in operation and a typical "mock missile" warhead package approaching the target are shown. Details of the sled design and fabrication and of the warhead package design and fabrication are presented. Sled track instrumentation is discussed. This instrumentation includes foil make/break switches and associated time interval meters (TIM) and digital delay units (DDU), magnetic Hall-effect transistors for measuring sled trajectory, and flash x-rays (FXR). Methods for timing the x-rays are presented. Schematic functional diagrams of the experimental setups are also given. Evidence of the ability to accurately time the delay between precursor and main warheads for even very long time delays are presented. FXR pictures illustrate the dynamics of the interaction of the jets with various target elements. The interaction dynamics of the jets is discussed in relation to the overall penetration performance of the tandem warhead. The use of x-ray fluorescence spectroscopy to help diagnose interaction dynamics is illustrated. The results of a test utilizing the missile propulsion rocket motor as a blast shield is presented in this paper. 2 refs., 22 figs.

31327 (ORNL/TM–11276) **Arsenal of democracy in the face of change: Four US mobilizations: A macroeconomic perspective working paper No. 5.** Horwich, G. Oak Ridge National Lab., TN (USA). Apr 1990. 50p. Sponsored by U.S. Federal Emergency Management Agency. DOE Contract AC05-84OR21400. Agreement EMW-84-E-1737. Order Number DE90008215. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Opinions on the magnitude of previous US mobilizations vary. This study attempts to resolve these differences by examining US government expenditures as a fraction of the GNP and the magnitude and sources of manpower during wartime. The level of US government national defense expenditures and the simultaneous deployment of manpower, both military and civilian, is taken to be the measure of mobilization. The paper examines the total magnitude of expenditures and manpower in each mobilization, the timing of its implementation and wind-down, and the ease with which the macroeconomy appeared to adapt to the war time conversion. Taking as the bottom line measure of the magnitude of each war, the increment between the premobilization percentage of government expenditures on defense and the average percentage sustained during the mobilization years, then WW II is the largest mobilization at 36.3%. WW I is next at 9.6%, the Korean War is almost a third less at 6.6%, and Vietnam is a minuscule 1.2%. Premobilization military strength was low in both World Wars while for Korea and Vietnam, it was already relatively high. The additional manpower in each of the four mobilizations came from a reduction in prevailing levels of employment, an increase in the working-age population, and an increase in the rate of labor force participation. 10 tabs.

31328 (UCRL-ID–103172) **Engineering drawing transfer test with the Air Force Ogden Air Logistics Center: MIL-D-28000 Class II (IGES): Quick short test report.** Lawrence Livermore National Lab., CA (USA). 16 Feb 1990. 4p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN–90-010). Order Number DE90010180. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document is a test report on computer-aided design software. Tests were performed to military standards. The tests were performed by Cals Test Network for the US Air Force. (FSD)

31329 (UCRL-ID–103173) **Technical publication transfer test with Pratt and Whitney: MIL-M-28001 (SGML) and MIL-D-28000 Class I (IGES): Quick short test report.** Lawrence Livermore National Lab., CA (USA). 16 Feb 1990. 5p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN–90-009). Order Number DE90010186. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document is a test report resulting from the evaluation of a software package from Pratt and Whitney by Cals Test Network. The IGES package is a computer aided design program. (FSD)

4501 Chemical Explosions and Explosives

Refer also to citation(s) 31322

31330 (SAND–90-0243) **Design of linear shaped charges using the LESCA [Linear Explosive Shaped Charge Analysis] code.** Vigil, M.G. Sandia National Labs., Albuquerque, NM (USA).

Apr 1990. 75p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010192. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Linear Explosive Shaped Charge Analysis (LESCA) code is used to analytically model and optimize the design of a linear shaped charge (LSC). A variety of LSCs are initially modeled with the LESCA code, and the predicted jet penetration versus standoff data are compared to experimental data. The LSCs varied in explosive loading size form 600 to 10,500 grains per foot. The LSC liner material for this study was cooper. The variables optimized in this study included the LSC apex angle, liner thickness, explosive width, and explosive width, and explosive height. 8 ref., 24 figs.

31331 (UCRL–102581) **Understanding composite explosive energetics: I, The role of metallic additives.** Tao, W.C.; Tarver, C.M.; Breithaupt, D.R.; McGuire, R.R.; Ornellas, D.L. Lawrence Livermore National Lab., CA (USA). [1990]. 12p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900254–3: 14. symposium on explosives and pyrotechnics, Burlingame, CA (USA), 13-15 Feb 1990). Order Number DE90010692. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Composite explosives (CE) have found major applications in air blast, cratering, fragmentation, underwater applications, and other commercial and military systems in which prompt delivery of the available energy is not a primary requirement. In direct metal acceleration applications, composite explosives have not generally been effective because their potential energy is transformed to kinetic energy over time periods extending to tens of microseconds. We are interested in defining the rate determining steps and understanding the chemical interactions between different components in the composite explosive formulation in order to determine the partitioning of the available energy. In this study, we investigate the role of the metallic additive in a bicomponent composite explosive consisting of PETN and aluminum. Of specific interests are the early time performance of and the extent of aluminum reaction in the composite formulation. For formulations loaded with 5 wt% and 10 wt% of 5 micron spherical aluminum, we found that 100% of the aluminum reacted within the first microsecond of volume expansion. The extent of aluminum reaction with the PETN detonation products is reduced to about 65% for composite formulations loaded with 20 wt% aluminum. It is evident from the results of a series of scaling experiments that the detonation behavior of the PETN-aluminum bicomponent composite explosive is nonideal. 6 refs., 11 figs., 2 tabs.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 30482, 30484

31332 (LA–11809-MS) **Los Alamos Critical Experiments Facility 1989 program review.** Leonard, E.M.; Plassmann, E.A.; Malanify, J.J.; Spriggs, G.D.; Anderson, R.E. Los Alamos National Lab., NM (USA). May 1990. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90008213. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Annual Program Review for the Los Alamos Critical Experiments Facility (LACEF) drew attendees from throughout the nuclear criticality community. They discussed the importance of the LACEF to their programs and stressed the uniqueness of the facilities available at the LACEF and the importance of doing numerous criticality experiments for a variety of programs. On-going and proposed activities were presented by the staff. 1 ref., 8 figs., 6 tabs.

4503 Nuclear Explosion Detection

Refer also to citation(s) 30639

4504 Nuclear and Radiological Warfare

31333 (AD-A–217339/1/XAB) **Validity of conventional assumptions concerning flexible response. Research report.** Gutierrez, M.J. Air Univ., Maxwell AFB, AL (USA). Air War Coll. 1989. 50p. Available from NTIS, PC A03/MF A01.

The North Atlantic Treaty Organization is an alliance for collective defense. Made up of 16 countries, NATO has been a successful alliance because there has been no war in Europe since 1945. In 1967, NATO adopted the strategy of flexible response, a strategy dependent upon conventional, tactical nuclear, and strategic nuclear weapons to provide deterrence from a Warsaw Pact attack. Although successful, NATO is suffering from an erosion in conventional strength. NATO continues to make assumptions about its conventional capabilities to successfully meet the requirements of the flexible response strategy. In the present day world of NATO, there is limited funding, a fact that is not likely to change any time in the foreseeable future. Limited funding makes it impossible to buy all the conventional force structure needed to ideally support the current strategy, also a fact that is unlikely to change. This paper shows limitations in some of the ways NATO assumes it can conventionally perform its mission. It is the author's position that NATO should modernize its conventional thinking to make it more in line with the realities of the situation NATO finds itself in today.

31334 (AD-A–217501/6/XAB) **Command, control, and communications command post in space: A further step for nuclear deterrence and preserving national security. Research report.** Raduege, H.D. Air Univ., Maxwell AFB, AL (USA). Air War Coll. May 1989. 49p. Available from NTIS, PC A03/MF A01.

A U.S. congressman thinks U.S. forces are at the brink of being out of control from a loss of communications. This paper describes the critical need for survivable national-level command, control, and communications. (C3). Brief description of the threat the U.S. faces from the Soviet Union with particular emphasis on growing space-based capabilities. General vulnerabilities of the U.S. National Command Authorities and supporting systems are described. Attributes of space-based command, communications, and control are compared to current land, sea, and air capabilities. Developing a permanently manned C3 command post in space would benefit U.S. security strategy through significant enhancements to nuclear deterrence and the political, economic, psychological, and military instruments of national power.

4505 Strategic Defense Initiative

Refer also to citation(s) 31301, 31894

31335 (AD-A–217265/8/XAB) **US ASAT (antisatellite): Do we need it. Research report.** Baker, J.A. Air Univ., Maxwell AFB, AL (USA). Air War Coll. May 1989. 43p. Available from NTIS, PC A03/MF A01.

Remarks on some historical aspects in the development of antisatellite (ASAT) weapons within the United States and the Soviet Union introduce a brief discussion of the current status of ASAT development within the U.S. The vital importance of space systems for U.S. strategic and tactical interests is described, followed by a treatment of the Soviet military space threat to those interests – setting the stage for an in-depth review of U.S. ASAT policy issues. The author addresses several of the outstanding issues, questions, and concerns about ASAT, including its appropriateness, military essentiality, impact on arms control, and its close relationship with Ballistic Missile Defense initiatives. The purpose is to highlight the diversity and significance of the issues concerning ASAT development and to demonstrate the importance these issues have on current and future U.S. military space policy.

31336 (AD-A–217348/2/XAB) **Assessing the morality of using the space environment as a platform for weapons. Research report.** Caffall, W.E.; Stafford, R.G. Air Univ., Maxwell AFB, AL (USA). Air War Coll. May 1989. 74p. Available from NTIS, PC A04/MF A01.

Remarks about President Ronald Reagan's hope of developing a system of national defense which does not rest on the reliance on nuclear weapons introduce the discussion on how US citizens expect their military to conduct war. A description of the Just War Theory and the Law of Armed Conflict completes the background for the authors' views of how space weapons could significantly change US employment of the Principles of War. The dramatic enhancements to the Principles of War available through space weapons apply to the full spectrum of conflict and promote the very

real possibility of truly limiting war. The analysis of the Just War Theory, the Law of Armed Conflict, and the space-enhanced Principles of War resulted in the conclusion that a more moral means of warfighting does exist than reliance on weapons of mass destruction and indiscriminate killing. The space environment offers that hopeful solution.

31337 (AD-A-217610/5/XAB) **Towards SDS (Strategic Defense System) testing and evaluation: A collection of relevant topics. Final report.** Brykczynski, B.R.; Youngblut, C. Institute for Defense Analyses, Alexandria, VA (USA). Jul 1989. 160p. (IDA-M-513). Available from NTIS, PC A08/MF A01.

IDA Memorandum Report M-513 is a compendium of position statements received at a two-day invitational workshop hosted by the Institute for Defense Analyses (IDA) in September 1988. The purpose of the workshop was (1) to determine the critical gaps in software testing and evaluation technology and (2) to assess current research efforts toward resolving these deficiencies. The specific focus of the workshop was technology for the testing and evaluation of the Strategic Defense System (SDS) software. The workshop was designed to bring together leading researchers in the field of software testing and evaluation and government agencies involved in major software development efforts. The participants were divided into four groups, respectively addressing the areas of testing and analysis, formal verification, measurement, and reliability assessment.

31338 (AD-A-217617/0/XAB) **Thrust and parry of the SIOP (single integrated operational plan) and sdi (strategic defense initiative). Research report.** Zank, G.D. Air Univ., Maxwell AFB, AL (USA). Air War Coll. May 1989. 64p. Available from NTIS, PC A04/MF A01.

The relationship between strategic offensive capabilities (reflected in the SIOP) and emerging strategic defensive capabilities (reflected by SDI) is not being adequately addressed. A summary of the existing nuclear war planning process is provided, and an analagous defensive process is postulated. Parallels and differences between the two processes are discussed. Potential areas for information exchange and cooperation are identified to enhance deterrence and improve war fighting potential. Operational, technical and political issues requiring resolution are raised and recommendations to resolve these issues are made.

31339 (ORNL/TM-11514) **Effects of x-radiation on the LAMPSHADE orbital debris satellite shield—II.** Smith, M.S.; Santoro, R.T. Oak Ridge National Lab., TN (USA). Apr 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE90008214. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

One-dimensional thermo-hydrodynamic calculations have been performed to estimate the response of the lead (Pb) bumper plate and aluminum (Al) foam liquidator screen of the LAMPSHADE orbital debris satellite shield. Mass fractions in the solid, liquid, and vapor phases as a function of time after irradiation for two incident x-ray spectra, were calculated using the PUFF-TFT code. Materials losses due to phase changes did not exceed 3%, but fracture and spallation may seriously reduce the performance of the lead component against incident debris. 3 refs., 3 figs., 2 tabs.

4506 Chemical and Biological

31340 (AD-A-217074/4/XAB) **Assessment of the ability of amphibious assault ship (LHA class) to perform sustained air operations in a chemical environment. Final report.** Henry, B.C.; Laughlin, L.L. Defense Information Analysis Center, Edgewood, MD (USA). 10 Mar 1988. 49p. Available from NTIS, PC A03/MF A01.

This report describes how an attack with chemical warfare agents would affect air operations on an LHA operating in support of an amphibious assault. This report overlays a chemical attack on normal flight deck operational sequences and describes in detail how having to operate in a chemically contaminated environment affects the sortie rate of troop airlift (CH-46 and CH-53 helicopters) and close air support (AH-1T) a their specific tasks while wearing the chemical protective overgarment, protective overboots and gloves. b. All the chemical defense equipment required by existing Navy directives is available and has been issued for use; c. Additional personnel required to conduct flight operations in a chemical environment are available and cross trained to perform tasks assigned in this study; d. There are no accidents, incidents, aircraft losses or battle damage which affect the tempo of flight deck operations; e. After four hours, the chemical contamination has been reduced sufficiently by weathering that flight deck personnel were able to reduce their protective posture to Mask Only. The report describes a series of recommendations to improve overall flight deck operations in a chemical environment.

31341 (AD-A-217127/0/XAB) **Aerosol sample acquisition for chemical and biological agent detection. Final comprehensive report, 15 April 1988-15 October 1989.** Marple, V.A.; Liu, B.Y. MSP Corp., Minneapolis, MN (USA). 1 Dec 1989. 122p. Available from NTIS, PC A06/MF A01.

The technical approaches to aerosol sample acquisition for chemical and biological agent detection have been analyzed and a sample acquisition system based on aerosol concentration and pyrolysis of the collected samplé has been selected for further theoretical and experimental investigation. Theoretical analysis of the virtual impactor concentrator has been made to determine the dependence of concentrator cut-size, pressure drop and power consumption on various design parameters. Parameters such as nozzle diameter, flow rate and number of parallel nozzles in the concentrator have been taken into account. An experimental 22 liters per minute concentrator has been designed, constructed and tested. The results indicate that the system studied have the desired characteristics for sample acquisition and analysis for the intended applications.

31342 (AD-A-217228/6/XAB) **CBR operations in cold weather: A bibliography. Volume 1. Special publication, September 1988-July619 89.** Carlon, H.R.; Birenzvige, A.; D'Eramo, P.A.; Parker, L.V. Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD (USA). Nov 1989. 88p. (CRDEC-SP-017-VOL-1). Available from NTIS, PC A05/MF A01.

Complex military operations can be severely hampered in cold weather. An extensive search of the literature has been completed, from which more than 60 reports and references have been selected for the comprehensive bibliography that is presented here in two volumes. Volume 1 includes only unclassified entries for convenient desktop reference, whereas, Volume 2 includes citations at the restricted, confidential, and secret levels. Both Volumes are cross-indexed by several schemes, including title, subject, author, and year. Abstracts for all references are provided, where available. This report is intended to provide an up-to-date guide to CBR operations in cold weather and to offer users the most authoritative information available concerning this topic.

31343 (AD-A-217405/0/XAB) **Department of Defense annual report on chemical warfare-biological defense research program obligations. Annual report, 1 October 1984-30 September 1985.** Office of the Under Secretary of Defense for Research and Engineering, Washington, DC (USA). 30 Sep 1985. 81p. Available from NTIS, PC A05/MF A01.

This report provides funding obligation information for the Department of Defense Chemical Warfare-Biological Defense Research Program.

31344 (AD-A-217439/9/XAB) **Lethality-rate estimation and testing procedures. Final report, 1 January 1985-1 January 1989.** Rust, S.W.; Feder, P.I.; Todt, F.R.; Joiner, R.L. Battelle Memorial Inst., Columbus, OH (USA). 11 Sep 1989. 87p. Available from NTIS, PC A05/MF A01.

Statistical methods were developed for the incorporation of the historical data accumulated on animal studies to enhance the statistical sensitivity of individual comparisons between standards and candidates. The basic idea is that the historical levels and variability of the standard can be used to predict a likely range for the concurrent standard in testing.

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5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 29937, 29974, 29988, 29990, 29992, 29994, 29995, 30005, 30006, 30063, 30311, 30312, 30314, 30315, 30316, 30378, 30458, 30460, 30469, 30573, 30633, 31283, 31318, 31427, 31439, 31440, 31445, 31447, 31481, 31482, 31483, 31484, 31486, 31487, 31491, 31500, 31501, 31502, 31504, 31505, 31506, 31507, 31509, 31510, 31511, 31512, 31513, 31514, 31515, 31517, 31518, 31533, 31543, 31595, 31597, 31624, 31636, 31637, 31642, 31894

31345 (AD-A-217444/9/XAB) **Cadmium and lead in biomedical waste incinerators. Master's thesis.** Hickman, D.C. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). 1988. 94p. (AFIT/CI/CIA-88-199). Available from NTIS, PC A05/MF A01.

The California Air Resources Board (CARB) has reported relatively high concentrations of cadmium and lead in recent tests of Bio-Medical Waste Incinerators (BMWI) in California. Cadmium and lead have been observed in the stack gas of incinerators before application of controls. Both metals appear to have been enriched in the fly ash. Sources of cadmium and lead in BMMWIs were investigated. Based on a review of the literature, compounds of cadmium and lead are used as heat and light stabilizers, and as pigments in various plastics, particularly in polyvinyl chlorides (PVC). The high HCl content of stack gases indicates a significant fraction of the waste stream contains chlorinated plastics. In samples analyzed from a hospital waste stream lead was found in several plastic items, as well as in paper packaging material. A source of cadmium was not positively identified, however, it appeared to be present in the casing of an alkaline battery. Both metals may also be present in inks, metallic items (needles, scalpels, etc), paper products, and paints. However, there was no evidence from which could be concluded that such items contributed to the observed levels of cadmium and lead. If sources of cadmium and lead can be identified, hospital administrators may be able to reduce or eliminate metal emissions by pressuring industry to change the composition of the source materials or by limiting their introduction into the incinerator waste stream.

31346 (AERE-R-13679) **ACIDTEST: a demonstration program for sulphur emission controls in Europe.** Derwent, R.G. (UKAEA Harwell Lab. (UK). Environmental and Medical Science Div.); Woods, K.J. UKAEA Atomic Energy Research Establishment, Harwell (UK). Jan 1990. 5p. Contract PECD-7/10/172. Available from HM Stationery Office, London, UK, price Pound 8.00.

ACIDTEST is a computer program which allows you to investigate the effect of sulphur emission control strategies on acid deposition in Europe. The program has been designed to run on an IBM PC, PS2 or compatible microcomputer running PC-DOS or MS-DOS. (author).

31347 (AERE-R-13684) **Optimal strategies for sulphur emission control in Europe.** Derwent, R.G. (UKAEA Harwell Lab. (UK). Environmental and Medical Science Div.). UKAEA Atomic Energy Research Establishment, Harwell (UK). Jan 1990. 83p. Contract PECD-7/10/172. Available from HM Stationery Office, London, UK, price Pound 14.00.

This study shows how a map of the critical load for sulphur deposition across Europe can be used together with a set of modelling tools to derive an optimal strategy for SO_2 emission control. The essential tools include the critical load maps, long range transport models, emission inventories, control technology costs for each country and optimisation algorithms. (author).

31348 (CEQ-90010530) **Environmental trends.** Johnston, D.; Curtis, C.; Jens, J.C.; Kane, L. (eds.). Council on Environmental Quality, Washington, DC (USA). 1989. 152p. Sponsored by Council on Environmental Quality. Order Number DE90010530. Available from OSTI; GPO; Council on Environmental Quality, Executive Office of the President, Washington, DC.

The Council on Environmental Quality is required, by the National Environmental Policy Act of 1969, to report on the status and condition of the environment; current and foreseeable trends in the quality, management, and utilization of the environment; and the effects of environmental trends. The Council reports to Congress in an annual report and maintains an archive of national environmental statistics, which it updates and publishes periodically in the annual report as statistical tables and in environmental trends report as charts, graphs, and maps. Environmental Trends updates the Council's 1981 report by that name. This sourcebook contains 367 graphics, most of which are computer generated and indicate current conditions and trends in the environment of the United States. The statistical series for Environmental Trends was compiled from data available through government agencies, private studies, or thee literature of each discipline. The data were reviewed and verified by experts at various federal agencies. National data are used wherever possible, with breakdowns shown when especially meaningful. The text is drawn from the published sources cited. 367 figs.

31349 (CNIC-00215) **A law of removing radon by ventilation and air requirement calculation for eliminating radon daughters in uranium mines.** Wu Gang (Ministry of Nuclear Industry, Shijiazhuang, HB (China). The Fourth Design and Research Inst.). China Nuclear Information Centre, Beijing, BJ (China). Jun 1988. 16p. (In Chinese). (FDRIN-0001). Order Number DE90626335. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In accordance with testing data of removing radon and its daughters by ventilation from shrinkage and filling stopes of uranium mines, a law of removing radon by ventilation from the stopes is analyzed and summed. According to the decay law of radon and its daughters, an accumulation equation of potential alpha energy from radon daughters is presented with hyperbolic regression equation. the calculating formulae of ventilation flow are derived from the accumulation equation for eliminating radon daughters in inlet flow with or without contamination. It has been proved that the amount of ventilation air calcuated could meet the requirements of radiation safety rationally and economically.

31350 (CNIC-00220) **Research and test for depressing radioactive dust and radon daughters and radioactive aerosols in situ with the technique of supervoltage static electricity.** Luan Hong (Ministry of Nuclear Industry, Shijianzhuang, HB (China). The Fourth design and Research Inst.); Zhang Wanqing; Yi Jinbao; Zhao Wenhuan. China Nuclear Information Centre, Beijing, BJ (China). Jun 1988. 7p. (In Chinese). (FDRIN-0002). Order Number DE90626336. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In some working-place of underground uranium mines and mills, the concentration of uranium ore dust, radon daughters and radioactive aerosols are very high. With conventional ventilation methods for eliminating these hazard materials, the efficiency is low, wherefore much more electric energy has to be consumed. A technique using supervoltage static electricity for depressing such hazard materials in situ is developed through tests. The technique has found a novel way to dust protection and radon elimination in the course of uranium mining and metallurgy.

31351 (CONF-8911158-2) **Acid rain in Asia.** Bhatti, N. (Argonne National Lab., IL (USA)); Streets, D.G.; Foell, W.K. Argonne National Lab., IL (USA). [1989]. 65p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract W-31109-ENG-38. From Workshop to design an acid deposition policy model for Southeast Asia; Bangkok (Thailand); 13-17 Nov 1989. Order Number DE90010459. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In Asia, fossil fuels are used in large quantities, such that local air pollution is becoming a serious problem and high deposition levels are being measured. Emission regulations in most countries (with the exception of Japan) are not very stringent. Energy plans in many countries call for very large increases in coal combustion in the future. Finally, there is not presently a strong constituency for action to mitigate the potential effects of acid deposition. These factors imply potentially serious problems in the future for long-range transport and deposition of sulfur and nitrogen species and consequent damage to ecosystems and materials. The political ramifications of transboundary environmental pollution in this region are also potentially serious. A predictive tool could be built to help decision makers project future trends in emissions, estimate the

regional consequences for acid deposition levels, evaluate the vulnerability of natural and man-made systems, and determine the costs and effectiveness of alternative mitigative actions that might be taken. Such a policy analysis exercise can start to raise environmental awareness in the region and begin a dialogue that could help ameliorate an environmental problem in its early stages. The purpose of this paper is to provide background information on the acid deposition situation in Asia, with the intention of laying the foundation for the design of a possible research program for this region. 41 refs., 10 figs., 9 tabs.

31352 (CPS–EPS7/AP/21) **National air pollution surveillance: Annual summary.** Environment Canada, Ottawa, ON (Canada). Conservation and Protection. Nov 1989. 94p. (MICROLOG–90-02194). Available from PC Canada Conservation and Protection, Environmental Protection Publications, Place Vincent Massey, 10 Wellington St, 12th Floor, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The National Air Pollution Surveillance Program is a joint project of the federal and provincial levels of government to monitor and assess, on a continuing basis, the quality of the ambient air in the urban regions of Canada. This annual summary presents data reported from 407 sampling instruments in 52 cities across the 10 provinces and the 2 territories. Measurements were made for sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, soiling index, suspended particulates, lead, dustfall and sulfation rate. The summary also compares the 1988 data with national air quality objectives for sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and suspended particulates. 1 fig., 20 tabs.

31353 (DOE/ER/12018–T6) **Solar variability, weather, and climate: Studies in geophysics.** National Academy of Sciences - National Research Council, Washington, DC (USA). Geophysics Research Board. 1982. 106p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018;FG01-80ER10757. Order Number DE90010448. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This volume contains 8 reports. Topics include solar variability, weather variability, climatic variability, effects of solar variations, dynamic coupling and solar-terrestrial effects. Individual reports are indexed separately on the energy data base. (KD)

31354 (EC–IP101) **The national incinerator testing and evaluation program: Characterization of residues from a modular municipal waste incinerator with line-based air pollution control.** Sawell, S.E. (Waste Water Technology Centre, Environment Canada, Ottawa, ON (Canada)); Constable, T.W.; Klicius, R. Environment Canada, Ottawa, ON (Canada). Sep 1989. 70p. (MICROLOG–90-02384). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The National Incinerator Testing and Evaluation Program (NITEP) was implemented in 1984 to examine the impact of municipal waste incineration on the environment and human health. This report describes the results of a NITEP study which evaluated ash from the Victoria Hospital energy from waste facility in London, Ontario. Concentrations of organic compounds were consistent with those recorded in other studies, although organic concentrations were higher in the fly ash than in the bottom ash The bottom and fly ash contained low to moderate concentrations of antimony, arsenic, boron, cadmium, cobalt, chromium, copper and nickel. They also contained high concentrations of aluminum lead and zinc. The bottom ash is much less soluble in water. However, large fractions of the cadmium, copper, lead and zinc present in the 3 types of fly ash are potentially available for leaching under acidic leaching conditions. All 4 types of ash would be considered hazardous if they were subject to existing regulations. The results from this study show a large difference between the leachability of the bottom ash and fly ash. Since the highly soluble fly ash contains much higher concentrations of toxic metals than the fairly insoluble bottom ash, it is recommended to collect the bottom ash and fly ash separately to facilitate treatment of the fly ash prior to disposal. 19 refs., 14 figs., 8 tabs.

31355 (EC/RRE–DR3-PMD89-8) **Detroit incinerator monitoring program: Windsor air sampling site, July 1987- September 1988; Walpole Island air sampling site, January 1988 - September 1988.** Environment Canada, Ottawa, ON (Canada). River Road Environmental Technology Centre. May 1989. 226p. (MICROLOG–90-02377). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Late in 1986, it was announced that a 4,000 ton/day municipal waste incinerator would be constructed in downtown Detroit, 6 km from the Canada-U.S. border. Concern for the impact of emissions from the incinerator on the air quality in Windsor led to the establishment of 2 monitoring sites, one in downtown Windsor and the other on Walpole Island. This phase of the program is designed to gather background data prior to the startup of the incinerators in the summer of 1989. The program includes ambient air measurements of polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF), polychlorinated biphenyls (PCB), chlorobenzenes (CB), chlorophenols (CP), polycyclic aromatic hydrocarbons (PAH), volatile organic compounds (VOC), inhalable particulate (IP) matter and metals. This report discusses the available monitoring data from the Windsor monitoring site from July 1987-September 1988 and from the Walpole Island site from January-September 1988. Most compounds tested were found in low quantities but were well within Ontario's air quality standards. IP concentrations and sulfate concentrations were found to be high at both sites on some summer sampling days, but not in excess of the provincial ambient air quality standards. 11 refs., 11 figs., 22 tabs.

31356 (EUR–12191) **30. 1988 meteorological year book of Ispra.** Bollini, B. (Commission of the European Communities, Ispra (IT). Joint Research Centre); Galva, A.; Gandino, C.; Porrati, E. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 87p. (In Italian). Available from NTIS (US Sales Only), PC A05/MF A01.

After a short description of the methods for measuring and elaborating atmospheric phenomena, many tables and graphics for the meteorological year 1988 are reported with English titles too. The measurements of solar irradiation are marked with the final hour following Italian winter time.

31357 (EUR–12223) **Measurements of environmental radioactivity, Ispra 1988.** Dominici, G. (Commission of the European Communities, Ispra (IT). Joint Research Centre). Commission of the European Communities, Luxembourg (Luxembourg). 1989. 50p. (In Italian). Available from NTIS (US Sales Only), PC A03/MF A01.

In this report there are briefly described the measurements of environmental radioactivity performed during 1988 by the site survey group of the Radioprotection Division at the Joint Research Centre Ispra Establishment. Data are given on the concentrations of Sr-90, Cs-137, and other radionuclides in precipitation, air, waters, herbage, milk and radioactive effluents. The environmental contamination is mainly a consequence of the nuclear accident of Chernobyl.

31358 (GKSS–88/E/55, pp. 19-59) **Dry and wet deposition of heavy metals and gases.** Michaelis, W. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Schoenburg, M.; Stoessel, R.P. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/ Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Close to the 'Postturm' a measuring station has been set up which shall supply particulars on the impact of the atmospheric deposition of heavy metals and inorganic gases on the forest. The results obtained so far suggest that with respect to the wet deposition of heavy metals no significant distinctions exist compared to

stands with forest decline in South Germany. The sulphate and chloride inputs are within the variation intervals at other sites while the total nitrogen deposition ranges near the upper border. The gas concentrations show a pronounced dependence on the meteorological conditions. The long-term average values were found to be in part markedly higher than at other sites. Ozone, however, requires particular attention. The impact of gaseous pollutants on the forest primarily occurs during short-term episodes with high peak concentrations. (orig./KG).

31359 (GKSS–88/E/55, pp. 61-79) **Qualitative and quantitative analysis of potential organic air pollutants of the site 'Postturm'.** Dommroese, A.M. (Natec-Gesellschaft fuer Naturwissenschaftlich-Technische Dienste mbH, Hamburg (Germany, F.R.)); Figge, K. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7376-A0. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

A research project will be described, which is being carried out systematically with the objective of qualitative and quantitative assessment of organic substances occurring in the air at forest 'sites' considering seasonal and meteorological variations. Hitherto, about 160 of the major organic substances occurring in the air at the 'site' have been determined. So-called reference substances have been selected as representatives of particular classes of substances. The alterations of concentrations in air at the 'site' of these reference substances are investigated as a function of meteorological conditions. (orig./KG).

31360 (IKE–2-89) **Development and verification of a micro-meteorological model for the determination of the concentration of trace amounts in dew water.** Bieder, U. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Nov 1989. 193p. (In German). Order Number DE90784838. Available from NTIS (US Sales Only), PC A09/MF A01.

Starting from measured micrometeorological conditions and measured trace gas concentrations in the air, the following processes are investigated with a new mathematical model: the condensation and evaporation rates of dew water, the solution and dissociation of the trace gases and the chemical reactions of the dissolved compounds. Extensive measurements were carried out for the model verification. The surface temperature of a new dew collector was registered during these experiments, as well as the amount of dew and the concentrations of some dissolved trace species. Finally, the model is verified by comparing these measured values with the calculated values of the simulated dew event. The model calculation shows, that the pH-value of dew is between 5 and 7 due to the high ammonia-concentrations in the surface layer of the atmosphere. According to these pH-values the sulfur dioxide concentrations in air around 10 ppb lead to sulfite concentrations in dew of about 10 μmol/l. (orig./KW).

31361 (ISH–128, pp. 75-80) **Preliminary results, model validation after Chernobyl.** Zeevaert, T. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

Observed model parameter values of (1) dry deposition velocity (Mo-99, Te-132, I-131, Cs-134, Cs-137); (2) wet deposition washout coefficient (Mo-99, Te-132, Cs-134, Cs-137); (3) interception factor and yield for grass (I-131, Cs-137); (4) concentration of I-131 and Cs-137 in milk. (HP).

31362 (ISH–128, pp. 81-93) **The distribution of the Chernobyl pollution in the Netherlands and an empirical relation for the transfer of radionuclides from dry and wet deposition to grass.** Vaas, L.H. (Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. voor Stralingsonderzoek). Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

On May the first the radioactive cloud reached the Netherlands. The time dependency of the measured total air activity in Bilthoven is shown. The gamma-exposure rate as a function of time, clearly demonstrates the dry deposition of radionuclides. On the third and fourth of May it rained, the effect of this wet deposition on the gamma-exposure rate is very pronounced. A simple model is presented to estimate the distribution of wet deposition. Results are compared with the results of a soil sampling programme. Empirical transfer factors for the transfer from wet and dry deposition to fresh grass are given. (orig./HP).

31363 (Juel–2337) **Ozone profiles at Juelich, FRG, during 1988 and 1989.** Smit, H.G.J.; Straeter, W.; Loup, H.; Kley, D. Forschungszentrum Juelich GmbH (Germany, F.R.). Inst. fuer Chemie 2 - Chemie der Belasteten Atmosphaere. Dec 1989. 75p. Order Number DE90785125. Available from NTIS (US Sales Only), PC A04/MF A01.

Ozone soundings were performed regular at Juelich, FRG (50deg 41' N, 6deg 24' E). This report, the first one of an intended series, contains information on technical aspects and presents vertical profiles obtained during 1988 and 1989. (orig.).

31364 (LIS–89) **Analysis of the spatial representativity of automatic air quality monitoring networks.** Beier, R.; Doppelfeld, A. Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.). 1989. 80p. (In German). Order Number DE90785034. Available from NTIS (US Sales Only), PC A05/MF A01.

The objective of the present study is an analysis of the reliability of the detection of spatial structures of pollutants by the automatic monitoring network TEMES operated in the Rhine-Ruhr district. For this purpose, a simple method for calculation and construction of lines of equal estimation error of the application of air quality data or parameters of monitoring sites to neighbored locations without monitoring equipment is presented and discussed using examples of sulfur dioxide. The method allows, apart from the direct neighborhood of heavy traffic carrying roads, to assess the spatial reliability of air quality parameters determined from monitoring networks and to characterise them by line of equal estimation errors. In this way, an objective comparison of the performance of air quality monitoring networks with respect to the detection of spatial structures becomes possible, even when the design criteria of these networks were different. In this way, for instance, monitoring networks from different member states of the European Community become comparable. The application of this method is not limited to sulfur dioxide, it can be extended to all pollutants monitored simultaneously in networks, for instance, nitrogen dioxide (apart from roads), suspended particulate matter, lead and ozone. (orig./EF).

31365 (MEW–89-4) **Aquatic sensitivity to acidic inputs: Manitoba.** Water standard and studies report, 89-4. Morelli, M. Manitoba Dept. of Environment and Workplace Safety and Health, Winnipeg, MB (Canada). 1989. 33p. (MICROLOG–90-02350). Available from PC Manitoba Environment and Workplace Safety and Health, 450 Broadway Ave., Room 156, Legislative Bldg., Winnipeg, MB, CAN R3C 0V8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The province of Manitoba together with British Columbia, Alberta, Saskatchewan, the Northwest Territories and Canada made a commitment in December 1982 to coordinate research activities related to the long range transport of air pollutants (LRTAP) in Western Canada. The objectives of this coordinated effort included the identification of current conditions in Western Canada, and the gathering of necessary information to develop appropriate management strategies to address LRTAP issues. This report deals with the mapping of aquatic sensitivity to acidic deposition. Water quality data collected between 1977 and 1986 were used to prepare Manitoba's aquatic sensitivity maps and used data for alkalinity, calcium and pH. It was found that waters highly sensitive to acidic

deposition are located mainly in the National Topographic Sections (NTS) 64F and 64C. Some highly senstive waters are also in NTS 63W and 63K. Medium sensitivity waters can be found in NTS 52L and 52M. The majority of water in the southern portion of Manitoba has low sensitivity. Detailed information for most of the northern areas of Manitoba is not available. 13 refs., 1 fig., 14 tabs.

31366 (OE–90-02407) **1986 Hamilton air quality.** Dobroff, F. (Ontario Ministry of the Environment, West Central Region, Toronto, ON (Canada)). Ontario Ministry of the Environment, Toronto, ON (Canada). Apr 1988. 98p. (MICROLOG–90-02407). Available from PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Ontario Ministry of the Environment operates a network of ambient air monitors throughout Hamilton, concentrated in the lower city, with the major station (Barton/Sanford) providing the data which formed the basis for the Hamilton Air Pollution Index (API). In 1985, 3 new major air monitoring stations were established in preparation for the new Air Quality Index. This report gives the results of a computer program known as a pollution rose, a cross-tabulation of hourly pollutant concentrations with wind direction classes, illustrated on various diagrams. For each rose presented, the length of each line drawn is proportional to the average concentration of a pollutant when the wind was blowing from that direction. Air quality in Hamilton in 1986 changed little from the previous year. The API reached the advisory level of 32 5 times in 1986 compared to 2 occasions in 1985. The network of high volume samplers measuring suspended particulates generally showed slightly higher levels in 1986. Dustfall jars located throughout the city to measure heavy settleable dust showed no significant change from previous years and remained well above objectives in the industrial and central area of the city. The network of fluoride monitors indicated similar concentrations to 1985. Gaseous pollutants showed little change, although ozone and reduced sulfur compounds continued to exceed criteria. A visual survey of silver maple foliage found light amounts of injury due to air pollution, but only at 3 locations close to the industrial complex. 8 refs., 26 figs., 12 tabs.

31367 (OWMC–90-01895) **Rational for the selection of technologies for treatment and disposal of special wastes in Ontario.** Ontario Waste Management Corporation, Toronto, ON (Canada). 3 Jul 1985. 30p. (MICROLOG–90-01895). Available from PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The Ontario Waste Management Corporation (OWMC) issued a status report on the conceptual engineering design of a system for treatment and disposal of liquid industrial waste and special waste in Ontario. The key components currently under consideration are a rotary kiln incineration plant, a physical/chemical treatment plant, a solidification plant, and a secure engineered landfill. In August 1984, the OWMC began a process to identify and evaluate the full range of alterative treatment/disposal options available for each system concept. This report discusses those alternatives, the process used for evaluating alternatives, and the results of that evaluation. The alternatives selected for evaluation were derived from published literature, telephone interviews with users and vendors of technologies, and visits to operating special waste treatment and disposal facilities in the U.S. and abroad over the past decade. Experimental and unproven technologies were reviewed but disregarded in the process selection because OWMC has elected to use only demonstrated processes. The report generally concurs with the technologies selected initially by OWMC and its consultants but further recommends that OWMC consider adding a biological treatment module (based on powdered activated carbon-activated sludge technology), if and when sufficient quantity of organic wastes received by the facility prove amenable to biological degradation. The report also provides the rationale for selecting incineration and biological processing for organic wastes, physical/chemicial treatment for inorganics, and solidification and disposal techniques for residues. 3 refs, 5 tabs.

31368 (PB–90-139627/XAB) **Verification tests of NOx and SO_2 emission abatement in a glass batch preheater. Final report, October 1, 1988-April 31, 1989.** Becker, F.; Cole, W.; Wysk, R. TECOGEN, Inc., Waltham, MA (USA). May 1989. 43p. (TR–4457-080-89). Available from NTIS, PC A03/MF A01.

The objective of the program was to determine the capture effectiveness of both NOx and SO_2 by a fluidized bed of glass batch. Glass batch is the raw material used to produce glass. Tests were conducted first in the laboratory, with flue gases from an oil-fired combustor, followed by field testing with slipstream flue gases from a production glass furnace. Results of both tests showed a very high capture of SO_2 (in excess of 90%), but only a minimal reduction in NOx levels (less than 10%). Along with the results of the work, likely reaction mechanisms are discussed.

31369 (PB–90-160086/XAB) **Radon reduction techniques in schools: Interim technical guidance.** Office of Radiation Programs, Washington, DC (USA). Oct 1989. 56p. (EPA–520/1-89/020). Available from NTIS, PC A04/MF A01.

The guidance contained in the document is based largely on research conducted in 1987 and 1988 in schools located in Maryland and Virginia. Because school design, construction and operation patterns vary considerably, it is not always possible to recommend standard corrective actions that apply to all schools. Therefore, the document covers background information on radon and radon mitigation experience, important school building characteristics relative to radon entry and mitigation, problem analysis, radon diagnostic testing, and radon mitigation system design and installation.

31370 (PB–90-166166/XAB) **Proposed best demonstrated available technology (BDAT) background document for K021. Volume 5.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 79p. (EPA–530/SW-90/011E). Available from NTIS, PC A05/MF A01.

See also Volume 4, PB–90-166158 and Volume 6, PB–90-166174. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This document explains how EPA determines BDAT, selects constituents for regulation, and calculates treatment standards. Section 2 presents waste-specific information–the number and location of facilities affected by the land-disposal restrictions, the waste-generating process, and waste characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which the proposed treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. The treatment standards are determined in Section 7.

31371 (PB–90-166372/XAB) **Proposed best demonstrated available technology (BDAT) background document for aromatics and other hydrocarbon U-wastes. Volume 26.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 83p. (EPA–530/SW-90/011Z). Available from NTIS, PC A05/MF A01.

See also Volume 25, PB–90-166364. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for selecting and developing the proposed treatment standards for aromatics and other hydrocarbons. Section 2 presents waste-specific information, i.e., the industry affected and waste characterization. Section 3 discusses the applicable and demonstrated technologies used to treat the waste (or similar wastes), and Section 4 summarizes the available performance data, including data on which the treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the calculation of proposed BDAT treatment standards.

31372 (PB–90-166521/XAB) **Proposed amendment to final best demonstrated available technology (BDAT) background document for organophosphorus wastes (K036 nonwastewaters). Volume 14. Draft report.** Berlow, J.R.; Cunningham, M.

Environmental Protection Agency, Washington, DC (USA). Office of Solid ,Waste. Nov 1989. 43p. (EPA–530/SW-90/012N). Available from NTIS, PC A03/MF A01.

See also Volume 13, PB–90-166513 and Volume 15, PB–90-166539. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This amendment presents a discussion of incineration as an additional applicable and demonstrated technology for treating disulfoton, the proposed constituent of concern in K036 nonwaste waters, EPA's determination of incineration as the best demonstrated available technology for K036 nonwaste waters, and EPA's rationale for transferring treatment performance data from incineration of K037 to K036 nonwaste water streams. More specifically, Section 2 of the document amends Section 3 of the 'Final BDAT Background Document for Organophosphorus Wastes' by adding incineration as an applicable and demonstrated technology for treating nonwaste water forms of K036. Section 3 of the document amends Section 4 of the Final BDAT Background Document for Organophosphorus Wastes by adding treatment performance data for incineration of K037 to develop treatment standards for K036 nonwaste waters. Section 4 amends Section 5.1, identifying incineration as BDAT for K036 nonwaste waters. Finally, Section 6 amends Section 7, proposing numerical standards for disulfoton based on treatment performance data for incineration transferred from K037 to K036 nonwaste waters.

31373 (PB–90-166588/XAB) **Calculation of BDAT (Best Demonstrated Available Technology) treatment standards for 30 BDAT list constituents. Volume 19.** Radian Corp., Herndon, VA (USA). Dulles Technology Center. Nov 1989. 20p. Available from NTIS, PC A03/MF A01.

See also Volume 19, PB–90-166562; Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

The document presents the technical support for the calculation of draft Best Demonstrated Available Technology (BDAT) nonwastewater treatment standards for 30 BDAT list constituents. The document discusses the treatment performance data that were used to develop these treatment standards and the calculation of these treatment standards. The treatment performance data from all 14 BDAT incineration tests conducted by EPA were considered in developing these treatment standards. A summary of these incineration tests is provided.

31374 (PB–90-167362/XAB) **Report to Congress on indoor air quality.** Environmental Protection Agency, Washington, DC (USA). Aug 1989. 421p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-167370 through PB–90-167404.

A separate abstract was prepared for the Executive Summary and each of the 3 main volumes of this act.

31375 (PB–90-167370/XAB) **Report to congress on indoor air quality. Executive summary and recommendations. Final report.** Environmental Protection Agency, Washington, DC (USA). Aug 1989. 31p. (EPA–400/1-89/001A). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs. See also Volume 1, PB–90-167388. Also available in set of 4 reports PC E99/MF E99, PB–90-167362.

This is a three-volume report plus executive summary with recommendations that fulfills the reporting requirement of Title IV Section 403(e) of the Superfund Amendments and Reauthorization Act of 1986. The report contains a description of the research and program activities in Federal agencies; a comprehensive overview of the current level of knowledge and uncertainties associated with the issue of indoor air quality; and an identification of the major gaps and research needs in indoor air quality.

31376 (PB–90-167388/XAB) **Report to Congress on indoor air quality. Volume 1. Federal programs addressing indoor air quality. Final report.** Environmental Protection Agency, Washington, DC (USA). Aug 1989. 87p. (EPA–400/1-89/001B). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs. See also PB–90-167370. Also available in set of 4 reports PC E99/MF E99, PB–90-167362.

The purpose of the report is to fulfill the requirement of Section 403(e) of the Superfund Amendments and Reauthorization Act of 1986 (SARA) that the Environmental Protection Agency (EPA) submit a report to Congress within two years of enactment describing the activities carried out under Title IV and making appropriate recommendations. The report consists of several components. This component, Volume I, is a description of the activities which have been conducted by various EPA offices within the past two years to address indoor air quality issues as well as similar descriptions from other Federal agencies. The material reflects both those activities explicitly mandated by Title IV as well as ongoing activities which impact indoor air quality.

31377 (PB–90-167396/XAB) **Report to Congress on indoor air quality. Volume 2. Assessment and control of indoor air pollution. Final report.** Environmental Protection Agency, Washington, DC (USA). Aug 1989. 252p. (EPA–400/1-89/001C). Available from NTIS, PC A12/MF A02.

Also available from Supt. of Docs. See also Volume 1, PB–90-167388 and Volume 3, PB–90-167404. Also available in set of 4 reports PC E99/MF E99, PB–90-167362.

The purpose of the report is to fulfill the requirement of section 403(e) of the Superfund Amendments and Reauthorization Act of 1986. The report consists of four volumes. This component, Volume 2, of the report discusses information on the risks, the economic impacts of pollution control methods, a description of current legislative authorities, and state, local, as well as private problems addressing the issue. It concludes with a discussion of the policy issues on a comprehensive Federal response to indoor air quality.

31378 (PB–90-167404/XAB) **Report to Congress on indoor air quality. Volume 3. Indoor air pollution research needs statement. Final report.** Environmental Protection Agency, Washington, DC (USA). Aug 1989. 51p. (EPA–400/1-89/001D). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs. See also Volume 2, PB–90-167396. Also available in set of 4 reports PC E99/MF E99, PB–90-167362.

The purpose of the report is to fulfill the requirement of section 403(e) of the Superfund Amendments and Reauthorization of 1986. The report consists of four volumes. This component, volume 3, reflects interagency perceptions of the near- and long-term research needs which exist to better characterize the range of indoor-air-quality concerns and identify technologically sound mitigation strategies.

31379 (PB–90-170002/XAB) **Toxic air pollutant/source crosswalk: A screening tool for locating possible sources emitting toxic air pollutants. Second edition. Final report.** Pope, A.A.; Brooks, G.; Moody, T.; Most, C.; Patterson, G. Radian Corp., Austin, TX (USA). Dec 1989. 766p. Available from NTIS, PC A99/MF A04.

See also PB–88-161146 and PB–88-163019.

This report presents the 2nd edition of the Air Toxic Pollutant/Source Crosswalk that associates emitting source categories with specific air-toxics compounds. This is a qualitative association and does not provide any information about the quantities of pollutants emitted. The crosswalk contains pollutant names, Chemical Abstract Service (CAS) numbers, Standard Industrial Classification (SIC) codes, and Source Classification Codes (SCC's). The report contains 15,000 associations for more than 1100 air-toxic compounds, and the second edition revises and expands the report. A software system, XATEF, containing the crosswalk has been developed for easy access and updating of the data. Use of the system is explained in the EPA report, Crosswalk Air Toxic Emission Factor Data Base Management System User's Manual. EPA is making available the system and data base records to agency users upon request. The purpose of the report is to offer a technical service to air pollution control agencies in performing preliminary assessments of the types and sources of toxic compounds in an area. The crosswalk helps agencies to identify the potential of pollutants to be emitted from sources in an area.

31380 (PB–90-171570/XAB) **Southern California Air-Quality Study: Toxic air contaminants, Task 1. Final report.** Hisham, M.W.M.; Grosjean, D. DGA, Inc., Ventura, CA (USA). Jan 1990. 113p. Available from NTIS, PC A06/MF A01.

See also PB–89-187322.

As part of the Southern California Air Quality Study (SCAQS), intensive measurements of peroxyacetyl nitrate (PAN) have been carried out by electron capture gas chromatography (EC-GC). Under the conditions employed for PAN measurements, all chromatograms of ambient air recorded during SCAQS also contained information on ambient levels of toxic chlorinated hydrocarbons. The objective of the project was to retrieve this information, i.e., to identify these chlorinated hydrocarbons to carry out EC-GC laboratory calibrations under conditions identical to those used during SCAQS, and to use the calibration data to calculate ambient levels of toxic chlorinated hydrocarbons during SCAQS (June to December 1987).

31381 (PB–90-171588/XAB) **Potential effects of global climate change on the United States. Appendix C: Agriculture, Volume 1. Final report.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Dec 1989. 302p. Available from NTIS, PC A14/MF A02.

See also PB–89-161046, PB–89-161053, PB–89-161061 and Volume 2, Appendix C, PB–90-171596.

This appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989). Volume 1 of the studies includes the effect of climatic changes on Agricultural production.

31382 (PB–90-171596/XAB) **Potential effects of global climate change on the united states. Appendix C: Agriculture, Volume 2. Final report.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 236p. Available from NTIS, PC A11/MF A02.

See also PB–89-161046, PB–89-161053, PB–89-161061 and Volume 1, Appendix C, PB–90-171588.

This appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989). Volume 2 of the studies includes effects of Climatic changes in the United States.

31383 (PB–90-171778/XAB) **Guidelines for conducting the AHERA (Asbestos Hazard Emergency Response Act) TEM (Transmission Electron Microscopy) clearance test to determine completion of an asbestos abatement project. Final report.** Chesson, J.; Leczynski, B.; Berner, T.; Hudson, T. Chesson Consulting, Washington, DC (USA). May 1989. 31p. Available from NTIS, PC A03/MF A01.

Asbestos abatement carried out in schools is subject to regulations under the Asbestos Hazard Emergency Response Act of 1986 (AHERA). The AHERA rule (40 CFR Part 763) includes procedures for determining when an asbestos abatement site is sufficiently clean for the containment barriers to be removed. After the abatement site has been subject to a thorough visual inspection, air samples are collected. In most cases, the samples must be analyzed by transmission electron microscopy (TEM). The document provides guidance for conducting the TEM clearance test with emphasis on interpretation of the results. The three components of the test, the Initial Screening Test, the Blank Contamination Test, and the Z-test, are described and illustrated with numerical examples.

31384 (PB–90-171968/XAB) **Potential effects of global climate change on the United States. Appendix A. Water resources. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 333p. (EPA–230/05-89/051). Available from NTIS, PC A15/MF A02.

See also PB–89-161046, PB–89-161053 and PB–89-161061.

Topics of discussion include: Interpretation of hydrologic effects of climate change in the Sacramento-San Joaquin River Basin, California; Methods for evaluating the potential impacts of global climate change: case studies of the State of California and Atlanta, Georgia; The impacts of climate change on the salinity of San Francisco Bay; Effects of climate changes on the Laurentian Great Lakes levels; Impact of global warming on Great Lakes ice cycles; Potential climate changes to the Lake Michigan thermal structure; The effects of climate warming on Lake Erie water quality; Impacts of global warming on runoff in the upper Chattahoochee River Basin; and Potential impacts of climate change on the Tennessee Valley Authority Reservoir system.

31385 (PB–90-172032/XAB) **In-depth survey report of Transcon Lines Inc., Camp Hill, Pennsylvania. September 1988.** Zaebst, D.D. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. Aug 1989. 47p. (IWS–146.18). Available from NTIS, PC A03/MF A01.

An in-depth survey report was conducted at Transcon Lines, Inc., Camp Hill, Pennsylvania to determine relative exposures to diesel aerosol among the four major presumably exposed job groups of road drivers, local drivers, dock workers, and mechanics. Elemental carbon sampling results at the Transcon Lines terminal during mild weather indicated low level exposures below geometric mean ambient highway concentrations in mechanics and local drivers, exposures slightly above highway concentrations in road drivers and switchers, and exposures significantly above highway concentrations in dock workers. Geometric mean exposures to submicrometer elemental carbon in all jobs were significantly elevated above the geometric mean ambient concentration measured in a residential area in Harrisburg. Relative job rankings suggested by personal exposures to elemental carbon, oxides of nitrogen and respirable dust were similar: lowest for mechanics, highest for dock workers, and intermediate for local and road drivers. Area concentrations of other airborne diesel exhaust components measured were very low or not detected and far below any established limits.

31386 (PB–90-172230/XAB) **Potential Effects of Global Climate Change on the United States. Appendix F. Air quality. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 209p. (EPA–230/05-89/056). Available from NTIS, PC A10/MF A02.

See also PB–89-161046, PB–89-161053 and PB–89-161061.

This appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

31387 (PB–90-172297/XAB) **Potential Effects of Global Climate Change on the United States. Appendix E. Aquatic resources. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 182p. (EPA–230/05-89/055). Available from NTIS, PC A09/MF A01.

See also PB–89-161046, PB–89-161053, and PB–89-161061.

This appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

31388 (PB–90-172305/XAB) **Development of test procedures to determine emissions from open burning of agricultural and forestry wastes. Final report on Phase 1.** Jenkins, B.M.; Chang, D.P.Y.; Raabe, O.G. California Univ., Davis, CA (USA). Jan 1990. 109p. Available from NTIS, PC A06/MF A01.

The University of California-Davis designed, constructed and demonstrated a test system to determine air-polluting emissions from the open burning of agricultural and forestry wastes. The system consists of a conveyer and fan, contained in a tunnel and hood enclosure, which allow emissions quantification while maintaining known environmental and fuel parameters. Several shakedown runs were conducted, using rice straw as fuel, to evaluate the operability and performance of the system. A final series of demonstration runs, using rice straw fuel, showed the reproducibility of emission measurements. The emission rates for SO2, NOx and particulate matter were comparable to those measured at the University of California-Riverside in a much earlier study. In a subsequent project, the University will use the test system to quantitatively determine emissions from the simulated open burning of a variety of agricultural and forestry waste materials.

31389 (PB–90-172586/XAB) **Development of county-level wind-erosion and unpaved-road alkaline emission estimates for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Documentation. Final report.** Barnard, W.R. Pechan (E.H.) and Associates, Inc., Durham, NC

(USA). Jan 1990. 174p. (EPA–600/7-90/005). Available from NTIS, PC A08/MF A01.

For system on diskette, see PB–90-501412.

The report details the methods used and the result of the conversion of the National Acid Precipitation Assessment Program's (NAPAP's) alkaline-material emissions information for wind erosion, unpaved roads, and dust devils from their current spatial resolution to county-level resolution. Additionally, methods for converting the county-level data to NAPAP's Modelers Inventory grid system are proposed. NAPAP is developing a nationwide emissions inventory of substances contributing to acid precipitation. Also of interest are substances that can neutralize acids in precipitation. Information from NAPAP's natural sources task group on the emissions of alkaline materials (calcium, magnesium, potassium, and sodium) is available, but the spatial resolution is not currently in a form that lends itself to use by either the National Emissions Data System or modelers using the NAPAP Resolved Modelers Inventory grid system.

31390 (PB–90-173188/XAB) **Potential Effects of Global Climate Change on the United States. Appendix J. Policy. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 190p. (EPA–230/05-89/060). Available from NTIS, PC A09/MF A01.

See also PB–89-161046, PB–89-161053 and PB–89-161061.

The appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

31391 (PB–90-173238/XAB) **Potential effects of Global Climate Change on the United States. Appendix D. Forests. Report to the Congress.** Smith, J.B.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. May 1989. 235p. (EPA–230/05-89/054). Available from NTIS, PC A11/MF A02.

See also PB–89-161046, PB–89-161053 and PB–89-161061.

The appendix contains back-up research studies for The Potential Effects of Global Climate Change on the United States report for Congress (1989).

31392 (PB–90-173469/XAB) **Inside Story: A Guide to Indoor Air Quality - how well is it working. Risk Communication Series. Final report.** Synstelien, D. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. 10 Jan 1990. 56p. (EPA–230/01-90/073). Available from NTIS, PC A04/MF A01.

The U.S. Environmental Protection Agency (EPA) and the U.S. Consumer Product Safety Commission developed a booklet entitled The Inside Story: A Guide to Indoor Air Quality, designed to provide information for the general public. The report describes the small-scale evaluation of the effectiveness of the booklet. The study appears to be one of the first attempts to determine how information materials requested by households actually are used by them. The evaluation examined the share of requesters who read the booklet; changes in their knowledge about indoor-air-pollution causes, and knowledge about testing and mitigation. The evaluation also asked whether respondents had tested or taken action to reduce their exposure to indoor air pollution.

31393 (PB–90-173907/XAB) **Toxic trace elements in urban air in Illinois.** Sweet, C.W.; Vermette, S.J.; Gatz, D.F. Illinois State Water Survey, Champaign, IL (USA). Jan 1990. 141p. Available from NTIS, PC A07/MF A01.

The airborne concentrations and sources of 17 toxic trace elements were evaluated in three polluted urban areas in Illinois: southeast Chicago, East St. Louis, and Granite City. Concentrations and meteorology were monitored between September 1985 and June 1988. Particle size distributions and vapor-particle partitioning were also measured during this period. Using the existing emissions inventories for the study areas, factor analysis and chemical mass balance analysis was applied to the data. This statistical analysis together with monitoring data show that most of the airborne trace elements in excess of background concentrations come from stack and fugitive emissions from heavy industry within the study areas. Elevated levels of chromium and manganese are caused by steel-related activities in Chicago and Granite City. Airborne cadmium, lead, zinc, and copper come from emissions from smelters in East St. Louis and Granite City. In all of these areas, fugitive emissions from wind-blown dust, materials handling, and vehicle traffic are important sources of airborne toxic trace elements. It is concluded that existing standards for airborne inhalable particles do not adequately control the levels of many toxic trace elements and that the first step in the control of these pollutants is to identify the sources of individual elements rather than sources of particulate matter in general.

31394 (PB–90-174434/XAB) **Clean Air Act amendments of 1989: Section-by-section analysis.** Environmental Protection Agency, Washington, DC (USA). Office of External Affairs. 20 Jul 1989. 72p. Available from NTIS, PC A04/MF A01.

Contents: provisions for attainment and maintenance of ambient air quality standards; provisions relating to mobile sources; hazardous air pollutants; permits; acid deposition control; provisions relating to enforcement; miscellaneous provisions.

31395 (PB–90-177874/XAB) **Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, CA. (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 37p. (EPA/ROD/R–09-89/044). Available from NTIS, PC A03/MF A01.

See also PB–89-204846.

The South Bay Asbestos Area site is at the northern end of the Santa Clara Valley and at the southern end of the San Francisco Bay, in San Jose, California. From 1953 to 1982 the site operated as an asbestos-cement pipe manufacturing plant with asbestos-contaminated waste being disposed of onsite in three landfills. In 1983 the State collected soil samples which revealed that asbestos was randomly distributed throughout AAlviso, including the Alviso Rim levee. The State also determined that the Guadalupe River levee contained asbestos-contaminated waste debris and soil. The first ROD addressed contamination at the rim levee. The second and final ROD addresses the asbestos contamination found at the remainder of the site. The primary contaminant of concern affecting the soil, debris, and air is asbestos. The selected remedial action includes paving approximately 128,500 square yards of an asbestos-contaminated truck yard and industrial yard; controlling dust emissions through monthly wet sweeping of streets; offsite disposal of asbestos-contaminated debris; air monitoring; and implementation of deed restrictions and other institutional controls.

31396 (PB–90-178302/XAB) **Communicating radon risk effectively: a mid-course evaluation. Interim report.** Smith, V.K.; Desvousges, W.H.; Fisher, A.; Johnson, F.R. Environmental Protection Agency, Washington, DC (USA). Office of Policy Analysis. Jul 1987. 244p. (EPA–230/07-87/029). Available from NTIS, PC A11/MF A02.

A panel of 2300 homeowners was divided into subgroups to test the effectiveness of six alternative ways of explaining the risk from naturally occurring radon gas. The research design focused on two dimensions: qualitative vs. quantitative and directive vs. evaluative. These characteristics led to 4 experimental booklets, which were compared with EPA's Citizen's Guide and a one-page fact sheet. The evaluation examined how much people learned about radon; whether they could form risk perceptions consistent with their home's measured radon level; and whether they felt they had enough information to make a decision about mitigation. The fact sheet did not perform well on any of these evaluation criteria. None of the five booklets clearly was best for all 3 evaluation criteria; the report discusses the implications for designing an effective radon-risk communication program.

31397 (PB–90-179896/XAB) **Fiscal year 1988 summary report of NOAA (National Oceanic and Atmospheric Administration) Meteorology division support to the US Environmental Protection Agency. Technical memo.** Poole-Kober, E.M.; Viebrock, H.J. National Oceanic and Atmospheric Administration, Silver Spring, MD (USA). Air Resources Lab. Dec 1989. 72p. (NOAA-TM-ERL-ARL–180). Available from NTIS, PC A04/MF A01.

See also PB–89-194294.

The Meteorology Division provided meteorological research and operational support to the U.S. Environmental Protection Agency. The primary research effort was the development and evaluation of air-quality simulation models using numerical and physical techniques supported by field studies. Modeling emphasis was on the dispersion of photochemical oxidants and particulate matter on urban and regional scales dispersion in complex terrain and the transport, transformation, and deposition of acidic materials. Highlights during FY-1988 included applying the Regional Oxidant Model (ROM) to evaluate the effects of proposed strategies to control anthropogenic hydrocarbons and NO sub x; implementing the ACID-MODES surface monitoring network and conducting an intensive ground and airborne sampling program to provide data for the evaluation of the Regional Acid Deposition Model (RADM); completing the Complex Terrain Dispersion Model (CTDM); completing the Acid Rain Mountain Mesoscale Model (ARM3); and conducting dense-gas dispersion studies in the Fluid Modeling Facility.

31398 (PB–90-180092/XAB) **NIOSH (National Institute for Occupational Safety and Health) criteria for a recommended standard: Occupational exposure to tetrachloroethylene (perchloroethylene).** Agatha Corp., Cincinnati, OH (USA). Jul 1976. 158p. Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs.

The report provides relevant data concerning the exposure of humans to tetrachloroethylene within the workplace. Recommendations for a tetrachloroethylene standard are provided based on analysis of data. The document covers the workplace environment, medical, labelling, protective equipment, emergency procedures, communication to employees of hazards of tetrachloroethylene, work practices, and monitoring and record-keeping requirements. Toxicity data are also presented.

31399 (PB–90-180100/XAB) **Criteria for a recommended standard - occupational exposure to toluene.** Clayton Environmental Consultants, Inc., Novi, MI (USA). 1973. 109p. Available from NTIS, PC A06/MF A01.

Also available from Supt. of Docs.

The report provides relevant data concerning the exposure of humans to toluene within the workplace. Recommendations for a toluene standard are provided based on analysis of data. The document covers the workplace environment (Air), medical, labelling (Posting), protective clothing and equipment, communication to employees of hazards from toluene, work practices, and monitoring and reporting requirements.

31400 (PB–90-180233/XAB) **Economic assessment of California field crop losses due to air pollution. Final report.** Howitt, R.E. California Univ., Davis, CA (USA). Dept. of Agricultural Economics. 1 Feb 1990. 52p. Available from NTIS, PC A04/MF A01.

The main goal of the study was to integrate the California Agricultural Resources Model (CARM) with the scientific crop-loss data base from the University of California-Riverside and to run the CARM model to evaluate the economic impact of ozone-caused crop losses on California farmers and consumers of California farm products. The results estimated that the total economic loss from the ozone damage to crops in California is approximately $333 million annually. A comparison of the regional benefits of reducing ambient ozone levels concluded that over 90% of the economic benefits to farmers of ozone reduction are concentrated in the San Joaquin Valley region. The study also evaluated several different alternative seasonal and hourly ozone standards. The estimated benefits range from $333 million annually for a .025 ppm seasonal ozone standard to $50 million annually for a .06 ppm seasonal ozone standard. The producer benefits range from $24 to $14 per acre. Given a net return of $60-$200 per acre for California field crops, the ozone reduction would substantially improve farm profits.

31401 (PB–90-180670/XAB) **Lidar observations of stratospheric aerosols in 1988 at Boulder, Colorado. Technical memo.** Eberhard, W.L.; McNice, G.T. National Oceanic and Atmospheric Administration, Boulder, CO (USA). Wave Propagation Lab. Oct 1989. 23p. (NOAA-TM-ERL-WPL–174). Available from NTIS, PC A03/MF A01.

See also PB–89-203871.

Profiles of aerosol-scattering ratio measured by ruby lidar at Boulder, Colorado, during 1988 are presented. The 21 profiles were obtained during the fourth year of a continuing program. The aerosol-scattering ratio in 1988 was substantially less than in any of the three previous years, continuing a trend toward a cleaner stratosphere. The peak in the annual-average profile was only 1.26 and was located at 20 km MSL.

31402 (PB–90-180696/XAB) **Health-hazard evaluation report HETA 87-367-1987, BMY Corporation: A division of Harsco Corporation, York, Pennsylania.** Hills, B.; Klincewicz, S. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1989. 36p. (HETA–87-367-1987). Available from NTIS, PC A03/MF A01.

An evaluation was made of exposure to paint solvents at BMY Corporation, (SIC-3795), York, Pennsylvania. Workers were apparently exposed to paint solvents during the touch up painting of military vehicles in the Final Processing and Small Parts Painting Departments. These workers suffered dryness of the nose and throat, headaches, and sleeplessness as well as menstrual cycle problems. Sampling was performed for 13 organic solvents and all were shown to be below the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits. Calculation of the combined exposure still indicated that the results were within the American Conference of Governmental Industrial Hygienists Threshold Limit Value for Mixtures. Preshift and postshift urine samples were collected from five workers. Blood samples were drawn from 20 workers and tested for immunoglobulin-G (IgG) and immunoglobulin-E (IgE) antibodies to hexamethylene-diisocyanate (822060) (HDI). Three of the employees demonstrated low levels of specific IgG antibodies to HDI, suggesting a past exposure. No specific IgE antibodies were noted. The report concludes that, while the exposure levels were below the limits allowed, the workers were exposed to several different chemicals which may have contributed to reported symptoms.

31403 (PB–90-180753/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony on a new asbestos standard by Anthony Robbins, April 17, 1990.** National Inst. for Occupational Safety and Health, Rockville, MD (USA). 17 Apr 1990. 9p. Available from NTIS, PC A02/MF A01.

See also PB–90-130063.

The testimony concerned the findings of a joint NIOSH/OSHA Work Group which reviewed recent scientific information about the health effects of asbestos. The study group reconfirmed that there is no safe exposure limit for asbestos and that all commercial and several noncommercial forms of asbestos cause disease. The report served to recommend to the Department of Labor that it promulgate a safer standard for workers exposed to asbestos and that it eliminate from the workplace all exposures from new nonessential uses of asbestos. The group asked that the new standard set a maximum workplace exposure limit of 100,000 fibers per cubic meter of air, the lowest level which can be accurately measured. The present level is two million fibers per cubic meter of air. Asbestos has been found to cause asbestosis, lung cancer and mesothelioma. Exposure to asbestos has also been related to significant increases in the incidence of laryngeal and gastrointestinal cancers. The group concluded that substitutes for asbestos be used whenever possible. Medical testing procedures for asbestos exposed workers should include chest x-rays, pulmonary function tests, and observation of respiratory and other clinical symptoms.

31404 (PB–90-182197/XAB) **Environmental Radiation Data: Report 58, April-June 1989. Quarterly report.** Environmental Protection Agency, Montgomery, AL (USA). Eastern Environmental Radiation Facility. Dec 1989. 45p. (EPA–520/5-89/034). Available from NTIS, PC A03/MF A01.

See also PB–90-113606.

Environmental Radiation Data (ERD) contains data from the Environmental Radiation Ambients Monitoring System (ERAMS). Data from similar networks operated by contributing States, Canada, Mexico, and the Pan American Health Organization are reported in the ERD when available. The ERAMS is comprised of nationwide sampling stations that provide air, surface, and drinking water and milk samples from which environmental radiation levels are

derived. Sampling locations are selected to provide optimal population coverage while functioning to monitor fallout from nuclear devices and other forms of radioactive contamination of the environment. The radiation analyses performed on these samples include gross alpha and gross beta levels, gamma analyses for fission products, and specific analyses for uranium, plutonium, strontium, iodine, radium, krypton, and tritium.

31405 (PB–90-182304/XAB) **Policy options for stabilizing global climate. Draft report to Congress. Volume 1, Chapters I-VI. Draft report.** Lashof, D.A.; Tirpak, D.A. Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Feb 1989. 408p. Available from NTIS, PC A18/MF A03.

See also PB–90-182312.

The report provides a general introduction to the climate-change issue and reviews selected previous studies. It discusses the greenhouse gases, their sources and sinks, chemical properties, current atmospheric concentrations and distributions, and related uncertainties and relates the greenhouse gases to the processes of climatic change. Once this link is made the report examines those human activities that affect trace-gas emissions and ultimately influence climate change. It discusses the scenarios developed to assist in thinking about possible future emissions and climate change and then presents sensitivity analyses of the modeling results. The report gives a detailed description of existing and emerging technologies that should be considered in the formulation of a comprehensive strategy for mitigating global warming, outlines domestic policy options, and discusses international mechanisms for responding to climate change.

31406 (PB–90-182312/XAB) **Policy options for stabilizing global climate. Draft report to Congress. Volume 2: Chapters VII-IX. Draft report.** Environmental Protection Agency, Washington, DC (USA). Office of Policy, Planning and Evaluation. Feb 1989. 457p. Available from NTIS, PC A20/MF A03.

See also PB–90-182304.

The report discusses different energy sources, fuels, and substitutes in different scenarios to either reduce or control the pollution which causes the greenhouse effect therefore changes the climate of the world. It describes the substitute technologies and other means by which greenhouse gas emissions could be reduced relative to the scenarios described. A range of policies that might be used to promote such reductions are described, which address domestic and international issues. The report discusses the diverse sources and economic activities responsible for greenhouse gas emissions. The primary means of accomplishing the goal of reducing greenhouse gas emissions is the development and use of technologies that reduce energy requirements (i.e., improve energy efficiency), use less carbon-intensive fuels, or that replace or reduce emissions of other greenhouse gases. In addition to this technological approach, there are also several areas in which management strategies are the means of reducing greenhouse gas emissions, particularly with respect to the buildup of gases resulting from some agricultural practices and forest resources.

31407 (PB–90-861964/XAB) **Asbestos exposure: Legislation, liability, and litigation. January 1985-February 1990 (a Bibliography from the Biobusiness data base). Report for January 1985-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 100p. Available from NTISPC N01/MF N01.

Supersedes PB–89-858203.

This bibliography contains citations concerning asbestos exposure resulting in legislation and lawsuits. Personal and corporate litigation cases are cited. Economic problems arising from lawsuits are presented. Monitoring for the determination of standards for legislation is also covered. Recent changes in Occupational Safety and Health (OSHA) and Environmental Protection Agency (EPA) rules and regulations are included. (This updated bibliography contains 214 citations, 56 of which are new entries to the previous edition.)

31408 (RIVM–228702020) **Air pollution around Amsterdam Airport Schiphol.** Van den Anker, I.M.; Van Velze, K.; Onderdelinden, D. Rijksinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Dec 1989. 72p. (In Dutch). Available from Rijksinstituut voor Volksgezondheid en Milieuhygiene (RIVM), P.O. Box 1, 3720 BA Bilthoven, Netherlands.

Complaints about the air pollution around Amsterdam Airport Schiphol and worries about possibly increased risk of cancer has led to a study of the air quality around the airport as influenced by the emissions of the aircrafts. Simultaneously the cancer mortality has been examined by the Municipal Health Office in Amsterdam. The cancer mortality in villages around the airport turned out to be comparable with that of a densely populated area. In the present study on the air pollution as caused by emissions of the airport, calculations were made with a dispersion model. The emissions were firstly deduced from recent publications and actual information on the air traffic. A quality check was made on the basis of concentration measurements at the airport terrain. The following compounds were considered: sulphur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds and polycyclic aromatic compounds. Emission numbers for sulphur dioxide and polycyclic aromatic compounds had to be adjusted to lower values. The contribution of the airport to the regional levels is given in the table for a point 3 kilometer east of the centre of the airport. For the considered compounds the calculated contributions were found to be less than 10%. An important contribution to the regional levels is due to emissions by road traffic on the highways in the considered area. As shown in the table the regional levels are higher than the national average levels but do not exceed the urban levels. Apart from the reported concentration measurements some samples of aerosols were investigated with the AMES-test. In none of the samples a microbial mutagenicity was found to be different from normal. 22 figs., 25 refs., 29 tabs., 4 apps.

31409 (UCRL-CR–103753) **Study of the global distributions of atmospheric radionuclides: Final progress report.** Lawrence Livermore National Lab., CA (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010749. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Radon-222, which emanates from the decay chain of Radium-226 found in soils, has a half-life of 3.8 days after which it decays to lead-210. We simulate transport of these species using GRANTOUR, a three dimensional Lagrangian chemical transport model. The model uses wind, precipitation and temperature fields from the NCAR Community Climate Model (CCM1). Radon and lead are used as tracers in the model to examine meso-scale transport and convection in the GCM and to verify the meteorological representation of the GCM. This study was performed running GRANTOUR in continuous January and July mode with 25000 parcels and a 12 hr time step. The standard or control model for this analysis is run using a vertical diffusion coefficient of 0.5 m^2/s. Sensitivity studies have been performed to determine the model's response to convection, vertical diffusion coefficient and wind speed. 8 refs., 3 figs., 2 tabs.

31410 (UCRL-ID–103171) **Summary of Hazards Control Department participation in B-624 incinerator miniburn and trial-burn series, January–February 1989.** Biermann, A.H.; Swearengen, P.M. Lawrence Livermore National Lab., CA (USA). Mar 1990. 78p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008187. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In November 1988 we were requested by the Administration and Operations Directorate to observe and participate in the stack-sampling portion of the B-624 incinerator miniburn and trial burn series of January–February, 1989. We procured equipment, conducted a dry run on January 20, 1989 Our sampling of the miniburn series was done in parallel with Acurex. We have compiled a summary of our participation and the results we obtained during our period of testing. We observed a number of procedures in the stack-sampling chemistry that were inconsistent with the Quality Assurance Project Plan (QAPP) of November 16, 1988 or Revision 1 of that document dated January 11, 1989. In this miniburn series, three Principal Organic Hazardous Constituent (POHC) feeds were incinerated. These were formaldehyde, formic acid, and phenol. During a burn, concurrent stack gas samples were withdrawn by the Acurex and LLNL sampling crews. In many

cases, samples were split and analyzed by both the Acurex Laboratories and the LLNL Chemistry Department. Samples taken by the LLNL sampling team and analyzed by LLNL yielded destruction and removal efficiencies (DREs) in excess of 99.999% for all POHC burns. A minimum DRE of 99.99% is required by the government agencies. Samples taken by and analyzed by Acurex were greater than 99.99% except for two formaldehyde burns. The lower-than-acceptable DREs were attributed to deviations in the QAPP, and were rectified in later testing. By far the most difficult part of the stack-sampling chemistry is that used for the collection and analysis of formaldehyde. A bibliography of pertinent literature on the subject is included. We have summarized the equipment used during this period of stack sampling for the convenience of the Environmental Protection Department if that capability is needed in the future. A detailed description of the equipment operation and performance is included here.

31411 (UCRL-JC-103279) **The value of on-site sodar data in regional modeling.** Nasstrom, J.S. (EG and G Energy Measurements, Inc., Pleasanton, CA (USA)); Baskett, R.L.; Lange, R. Lawrence Livermore National Lab., CA (USA). Feb 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48;AC08-88NV10617. (CONF-9004180–1: 9. symposium on turbulence and diffusion, Roskilde (Denmark), 30 Apr - 3 may 1990). Order Number DE90009921. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Three-dimensional dispersion modeling has many applications. At Lawrence Livermore National Laboratory, it is used both as a research tool and, by the Atmospheric Release Advisory Capability (ARAC), as an emergency response tool. ARAC uses a diagnostic three-dimensional regional modeling system built around the MATHEW (Mass-Adjusted Three-dimensional Wind field) and ADPIC (Atmospheric Dispersion Particle-In-Cell) models. Initializing these models requires meteorological observations to estimate the horizontal and vertical variation of the wind in the atmospheric boundary layer. These observations may be obtained from meteorological towers, tethersondes, rawinsondes, or remote sensing instruments. Standard twice-daily rawinsonde observations are readily available but may be outside the modeling domain and up to 12 hr old. Sodars such as the Doppler acousting sounder show promise in providing the necessary vertical wind inputs. If properly sited, one would expect that real-time soundings within the modeling domain would provide the best initialization of the upper level wind field. This paper attempts to assess the value of on-site vertical wind measurements to dispersion modeling in two different settings. One is the Savannah River, Georgia. The second is the Diablo Canyon Power Plant, California. 6 refs., 5 figs.

31412 (UCRL-JC-103587) **Nocturnal flow on a western Colorado slope.** Leone, J.M. Jr.; Gudiksen, P.H. Lawrence Livermore National Lab., CA (USA). Apr 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900534–2: 18. NATO/CCMS international technical meeting on air pollution modelling and its applications, Vancouver (Canada), 13-17 May 1990). Order Number DE90010863. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Department of Energy sponsored Atomspheric Studies in Complex Terrain (ASCOT) program has conducted a research program designed to increase our knowledge and understanding of terrain-dominated flows with specific emphasis on nocturnal flows within mountain valleys. ASCOT has sponsored both field studies and numerical modeling efforts to improve our understanding of the wind, temperature and turbulence structure of nocturnal drainage flows. One of the most recent ASCOT sponsored field studies involves a study within the Mesa Creek Basin in western Colorado to investigate the seasonal frequency of occurrence of drainage flows along the sloped surfaces and within the basin, and to evaluate the effect of the ambient meteorology on their development. The Mesa Creek Basin, situated on the north slope of the Grand Mesa, encompasses a roughly 10 x 20 km area that is approximately 30 km east of Grand Junction. The observational segment of the study was undertaken jointly by the Lawrence Livermore National Laboratory and the NOAA Wave Propagation Laboratory, and involved the operation of network of eight meteorological towers and a monostatic sodar within the Mesa Creek study area over a period of one year that extended from December 1988 through November 1989. These measurements were augmented by tethersonde observations to define the vertical wind and temperature structure during a few nights. The modeling portion of the study is being undertaken by Lawrence Livermore Laboratory using a three-dimensional prognostic boundary layer model to gain further insight into the dynamics of the seasonal variations and the effect of cloud cover on the development of the drainage flows. It is the purpose of this paper to present preliminary results form a numerical simulation done as part of this study. 4 refs., 7 figs.

31413 The use of calcium hydroxide as a binder in densified refuse derived fuel dRDF for reducing organic emissions: initial results from a 600 ton combustion study. Volume 1. Moore, P. (Univ. North Texas, Denton, TX (US)); Poslusny, M.; Daugherty, K.E.; Venables, B.J.; Ohlsson, O.O. 11p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-21.4.

Public concern over air pollution problems caused by smoking stacks on solid waste incinerators coupled with the availability of cheap iandfill sites brought about the closure of many of these incinerators in the early 1970's. More recently the burning of solid waste has again become popular proposition. Several factors have helped make this so: regulatory and environmental difficulties in the siting of landfills; large rises in the costs of solid waste disposal alternatives; significant increases in the amount of energy that can be produced from the waste; and the development of binderpelletized refuse derived fuel (dRDF). In this book the authors discuss their involvement in the development of dRDF. They examined over 1500 potential dRDF binders and binder combinations. A ranking system was set up looking at cost, environmental acceptability and effectiveness as a binder, this quickly cut the number of potential binders down to approximately 60. These were subjected to a more rigorous detailed analysis, including laboratory testing to further narrow the field to 13. In 1985, these binders were subjected to field testing at the Naval Civil Engineering laboratory test facility in Jacksonville, Florida. A series of chemical and physical tests were carried out on the pellets produced with these binders. Calcium hydroxide proved to be the top ranked binding agent.

31414 Assessing radon control options in new energy-efficient homes. Volume 6. Bamberger, J.A. (Pacific Northwest Lab., Richland, WA (US)); Baechler, M.C.; Foley, L.O.; Sandusky, W.F.; Harris, J. 13p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-106.4.

This paper reviews an analysis used in an environmental impact statement (EIS) for new energy-efficient homes programs. In the analysis the authors assess several combinations of mitigation and building techniques, which they call pathways, for their effects on indoor air quality. They pay particular attention to the pathways' effects on indoor concentration of radon, and potential health effects that may result for building occupants. They also assess the pathway's potential energy savings and costs. The most important variable in this analysis is the difference in ventilation rates between current practice and energy-efficient homes as defined by each of the pathways. In addition to health effects, the authors estimate energy savings (the main objective of Bonneville's program) and economic impact, giving policy makers a means of measuring trade offs when planning new program components. The paper provides a case study of how risk assessment, energy analysis, and economics were used as planning tools.

31415 Institutional obligation: Radon policy and strategy implementation. Volume 6. Rowan, S.S. (Bonneville Power Administration, Portland, OR (US)); Berwager, S.D. 9p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-106.2.

The institutional obligation is to act to meet primary responsibilities in the face of risks. There are risks involved in taking action,

both of a quantifiable and unquantifiable nature. This paper explores weighing the risks, choosing approaches that balance primary obligations with broader ones, and presenting ethical philosophies upon which policies and strategies are based. Federal government organizations and utilities–and Bonneville Power Administration qualifies as both–have a variety of responsibilities to the public they serve. The common responsibility is that of service; for Bonneville the primary responsibility is to serve the energy related needs. It is this primary institutional obligation, as it relates to other responsibilities–and the resulting strategy for handling indoor air quality in Bonneville's new homes program–that this paper examines.

31416 **Indoor volatile organic sampling study in Chattanooga, Tennessee.** Volume 6. Arkhurst, W.J. (Tennessee Valley Authority, Muscle Shoals, AL (US)); Lee, N.T.; Imhoff, R.E.; Duley, B.L. 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Report 88-109.7.

In June 1983, the Piney Woods Community Organization (PWCO), a citizens action group, initiated a dialogue with the Chattanooga-Hamilton County Air Pollution Control Bureau (Bureau) regarding community industrial air pollution problems. Complaints ranged from particulate fallout soiling clothes hung out to dry to various health effects. The PWCO specifically requested a community health survey, a list of all toxic air pollutants found in their community, and creation of a task force to develop an air toxics ordinance for Chattanooga. It became evident that a concerted effort to help identify and resolve the Piney Woods air quality issues would require significantly more resources than were available to the Bureau. Consequently, the Bureau requested assistance from the Tennessee Division of Health and Environment (TDHE) which in turn asked the Tennessee Valley Authority (TVA) to help. It was agreed that, under the overall direction of the Bureau, the TDHE would conduct the health survey, TVA and the Bureau would cooperatively address the air quality measurements, and the Bureau would address the air toxics ordinance with the assistance of local industry and the community. The health survey is discussed in this paper.

31417 **Development of computer-generated data packages for EPA analyses.** Demirgian, J.C. (Argonne National Lab., IL (USA). Analytical Chemistry Lab.); Hansen, M.C. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1594.

Analyses of environmental samples using the U.S. EPA procedures [SW-846 and Contract Laboratory Program (CLP)] required under the resource conservation and recovery act (RCRA) and Superfund require a high level of quality assurance/quality control (QA/QC). These analyses produce a large data package containing many mandated forms that are time consuming to complete. The required level of QA/QC greatly increases the cost of analysis in terms of the time required to perform calculations, fill out forms, and review the data package. The automation of the entire analytical process of reporting the data, from operation of the instrument is completion of the final data package through the use of personal computers, would decrease the analysis time and cost in these EPA analyses. This presentation evaluates three approaches to the production of automated packages. The objective is to describe how one can successfully develop and implement an automated data package capability.

31418 **Laser heating of droplets with absorbing core.** Park, B. (New Mexico State University, Physics Department, Las Cruces, New Mexico 88003-0001 (US)); Armstrong, R. *Applied Optics (USA)*, 29(3): 334-336 (20 Jan 1990).

The irradiation and heating of a spherical droplet containing an absorbing core are studied numerically using a corrected surface energy balance.

31419 **Beta/alpha continuous air monitor.** Becker, G.K.; Martz, D.E. To U.S. Dept. of Energy, Washington, DC. USA Patent 4888485/A/. 19 Dec 1989. Filed date 27 Jun 1988. USA Patent Application 7-211,647. Int. Cl. G01T 1/24. vp.

This patent describes an air monitor. It is comprised of: spectrographic detection means for sampling, measuring, and graphically displaying the energy levels of alpha and beta particles, curve fitting means for extrapolating curves depicting repeated measurements of the energy levels, and alarm means for signaling significant deviations from the extrapolated curves.

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Refer also to citation(s) 29999, 30002, 30009, 30029, 30030, 30062, 30064, 30066, 30069, 30070, 30148, 30151, 30316, 30378, 30469, 30869, 30891, 30892, 30894, 31348, 31357, 31358, 31361, 31362, 31371, 31395, 31417, 31458, 31478, 31479, 31480, 31481, 31482, 31483, 31484, 31486, 31487, 31489, 31490, 31491, 31492, 31493, 31494, 31495, 31496, 31497, 31498, 31499, 31500, 31501, 31502, 31503, 31504, 31505, 31506, 31507, 31509, 31510, 31511, 31512, 31513, 31514, 31515, 31516, 31517, 31518, 31525, 31527, 31528, 31531, 31532, 31533, 31535, 31536, 31538, 31539, 31577, 31595, 31603, 31604, 31636

31420 (CNIC–00258) **Determination of impulse response parameter alpha in the interpretation of gamma logging by deconvolution technique.** Lu Cunheng (Huadong Geological Coll., Fuzhou, JX (China)). China Nuclear Information Centre, Beijing, BJ (China). Nov 1988. 6p. (In Chinese). (HGC–0001). Order Number DE90626294. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The effect of the value of impulse response parameter alpha on the computation of ore content is discussed. An appropriate formual for calculating alpha value is presented. A series of alpha values are callculated by using this formula in various conditions, and its changing regularities are shown. The comparison of calculated alpha values with the experimental data are also given.

31421 (CONF-900210–47) **Radiological risk assessment of a radioactively contaminated site.** Devgun, J.S. Argonne National Lab., IL (USA). [1990]. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From 16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990. Order Number DE90010622. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A limited-scope preliminary assessment of radiological risk has been conducted at a radioactively contaminated site under current site use conditions and based on the available preliminary radiological characterization data for the site. The assessment provides useful input to the remedial action planning for the site. 8 refs., 1 fig., 2 tabs.

31422 (DOE/ER/60310–2) **Supercomputer simulation of clay-organic-water interactions: Phase 2: Progress report, April 14, 1989–December 31, 1989.** Cushman, J.H.; Diestler, D.J.; Low, P.F.; Roth, C.B. Purdue Univ., Lafayette, IN (USA). 11 Dec 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER60310. Order Number DE90010468. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the progress of the super simulation of Clay-Organics-Water Interactions Project for the period of April 14, 1989–December 31, 1989 and is broken into three sections. The first relates to the experimental program; the second to the computational program; and the third to the theoretical problems associated with scale. 2 refs.

31423 (EGG–10617-1013) **An aerial radiological survey of the Seabrook Nuclear Station and surrounding area, Seabrook, New Hampshire, July 1988.** EG and G Energy Measurements, Inc., Las Vegas, NV (USA). Remote Sensing Lab. Sep 1989. 14p. Sponsored by U.S. DOE Nuclear Safety; Nuclear Regulatory Commission. DOE Contract AC08-88NV10617. Order Number DE90010062. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An aerial radiological survey was conducted over the Seabrook Nuclear Station, Seabrook, New Hampshire, during the period 6 July through 14 July 1988. The purpose of the 247-square-kilometer (96-square-mile) survey was to document the terrestrial gamma environment of the station and surrounding area. An exposure rate contour map at 1 meter above ground level (AGL) was constructed from the gamma data and overlaid on an aerial photograph and map of the area. Exposure rates measured in the area typically ranged form 9 to 12 microroentgens per hour (μR/h). In areas where water shielded the earth, lower exposure rates were measured. Ground-based exposure rate measurements and soil samples were obtained to support the aerial data. Oblique aerial photographs of the station were also acquired during the survey. 9 refs., 5 figs., 1 tab.

31424 (GS/AR–Bull58) **Hydrogeology of the Swan Hill area, Alberta: Evaluation for deep waste injection.** Hitchon, B.; Sauveplane, C.M.; Bachu, S.; Koster, E.H.; Lytriak, A.T. Alberta Research Council, Edmonton, AB (Canada). Alberta Geological Survey. 1989. 73p. (MICROLOG–90-01796). Available from PC Geological Survey of Canada, Publications Distribution, 601 Booth St, Ottawa, ON, CAN K1A 0E8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $15.00 CAN; MF $10 CAN.

A detailed hydrogeologicial study was carried out in a region of 15,760 sq km centered on the deep waste injection site of the Alberta Special Waste Management Corp. The objective was the selection of aquifers for environmentally safe disposal of waste water from treatment processes. The approach included identification of the major hydrogeological and economic constraints, analysis of the natural flow system for all hydrostratigraphic units between the Lower Cretaceous Viking aquifer and the Precambrian basement, numerical simulation of the flow in the entire Phanerozoic succession to obtain conformance with the natural flow system, and steady-state perturbation of the system at an injection rate of 225 m^3/d in 2 potential injection aquifers to evaluate the importance of the hydraulic head buildups at a theoretically infinite time of injection. The study was based on examination and interpretation of stratigraphic information from 3,276 wells, and on 635 drillstem tests, 3,477 core analyses, and 645 formation water analyses, all from the files of the Alberta Energy Resources Conservation Board, using specialized software developed by the Basin Analysis Group, and the 3-dimensional finite element groundwater model FE3DGW. The preferred injection aquifer is the basal portion of the Wabamun-Winterburn aquifer system. The Basal Cambrian aquifer was selected as a less desirable backup injection aquifer. After completing this study, a well was drilled to the top of the Ireton aquifer and successfully tested and completed in the Wabamun-Winterburn aquifer system. 104 refs., 40 figs., 21 tabs.

31425 (GSF–12/89) **Transport of radionuclides through the food-chain. Final report. Pt. 1.** Jacobi, W.; Paretzke, H.G.; Friedland, W.; Mueller, H.; Proehl, G. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Nov 1989. 71p. (In German). Contract BMFT 1500 684 6. Order Number DE90784905. Available from NTIS (US Sales Only), PC A04/MF A01.

The objective of this part of the study was the estimation of the radionuclide transfer from deposition on agricultural areas to the main food products for radionuclides of potential relevance to the ingestion dose after accidents in nuclear power plants. For this purpose, the dynamic compartment model 'ECOSYS' was improved and adjusted for its application to the proposed nuclide spectrum. The contamination mechanisms of food products and influencing factors were considered, and a nuclide-specific and food-specific quantification of the contamination pathways was performed. For a number of 21 radionuclides time-dependent activity concentrations for 8 food products after single deposition of 1 Bq/m^2 on agricultural areas on January 1st and on July 1st were calculated for up to 200 years after deposition. After deposition in summer a far greater number of radionuclides may be relevant, and the contributions of the food products differ considerably from the results after deposition in winter. (orig.).

31426 (INIS-mf–12573) **Studies on the radiation absorption characteristics of various rocks.** Rahman, K.N.; Abdullah, S.A.; Gazzaz, M.A. King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Nuclear Engineering. May 1984. 98p. Order Number DE90626283. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Radiation absorption characteristics of nine different rocks, namely, ferrugenous quartz, metabasalt, larvikite, coarse grained diorite, coarse grained granite, coarse grained alkali granite, marble, quartz mica schist, and metamorphosed rock are studied. The rocks were collected from Jeddah, Makkah, Mina and Taif areas. Special attention was given on the availability, compactness, physical formation and uniform composition in selecting the rocks. The rocks were identified by optical method and their elemental composition determined by chemical analysis. The data were used to calculate the effective atomic numbers, half value layers mass and linear attenuation coefficients. The half value layers and the linear attenuation coefficientsof these rocks were determined experimentally using Am-241, Cs-137,and Co-60 sources. The results are compared with those obtained by theoretical calculations and agrre within 10%. Most of the rocks show much higher radiation attenuation characteristics than the standard concrete. Rocks containing higher percentage of Fe, Ca, Ti, and Mn show much higher radiation absorption characteristics than concrete. Only granites are found to be almost equivalent to concrete. 12 Ref.

31427 (ISH–128) **Experiences with radioecological assessment models, comparisons between predictions and observations.** Leising, C.; Wirth, E. (eds.). Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. 161p. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

The reliability of a prognostic calculation of radiation dose to man after releases of radionuclides into the environment depends on the quality of the radioecological model. Although there exists an abundance of models their reliability is often hardly known. Some investigations are done to improve different parameters. The models, however, have seldom been discussed as a whole. The main aim of the workshop was to analyse the experience with radioecological assessment models by comparison between predictions and observations and to discuss possible ways to diminish the gap in our knowledge. The eleven contributions to the workshop are separately indexed in the database. (orig./HP).

31428 (ISH–128, pp. 16-27) **Uncertainties of predicted soil-to-plant transfer factors because of averaging the impact of space, time, local conditions and crop variety.** Frissel, M.J. (Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands)); Koster, J. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radioecological assessment models, comparisons between predictions and observations.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

This manuscript deals with the uncertainties which are associated with the estimates of the mean soil-to-plant transfer factors which are based on the IUR (International Union of Radioecologists) data base. Some features of this project are described. (orig./HP).

31429 (ISH–128, pp. 28-35) **The usefullness of K_D models for the description of the migration of radionuclides in soils.** Pennders, R.M.J. (Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands)); Frissel, M.J. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

For radionuclides which are reversibly adsorbed and the K_D (ratio between the amount of radionuclides adsorbed on a soil and the amount present in the liquid phase) is so small that migration due to bioturbation is small compared to physical chemical migration,

the K_D concept is valid. Irreversible adsorption phenomena decrease the usefulness of the K_D concept. For very high K_D values the concept cannot be used for the upper layers of soil because migration due to bioturbation dominates in this case. (orig./HP).

31430 (ISH–128, pp. 36-42) **Improving models.** Wirth, E. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene); Gall, M.; Leising, C. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radioecological assessment models, comparisons between predictions and observations.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

It is shown, that improving a parameter means to minimize the distribution of the parameter values so that at least the range of the results gets smaller. Special emphasis is put on the transfer processes soil/plant, feed/meat or milk and water/fish. Basically three methods are suggested to minimize the distributions of the individual parameters and the results: By including measured specific parameters instead of standard parameters, by considering important parameters within equations to describe a transfer process and by considering the antagonismens between radionuclides and regulated essential elements and introducing the OR (observed ratio) factor. (orig./HP).

31431 (ISH–128, pp. 94-100) **The Chernobyl contamination of grass and milk in the Netherlands, validation of the transfer coefficient F_m for caesium.** Koester, H.W. (Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. voor Stralingsonderzoek). Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

In the Netherlands the Cs-137 contamination of grass and milk is monitored seperately in different locations since 1960. National averages are estimated for the summers of 1983, 1984 and 1985 before Chernobyl, and for the months of May through October 1986 subsequent the deposition of Chernobyl fall-out. The total Cs-137 intake by grazing lactating dairy cows is estimated and the corresponding values of the transfer coefficient F_m are calculated. In May 1986 the value of F_m is considerably lower than the IAEA default value; 0,0001 d/l in the first fortnight and 0,004 in the second fortnight. This is ascribed partly to the non-equilibrium situation. In the practically equilibrium situations before and following the first month after the Chernobyl fall-out the estimated values and the IAEA default value of F_m are of the same order of magnitude; when rounded off all are equal to 0,01 d/l. (orig.).

31432 (ISH–128, pp. 101-115) **Tritium in the pasture - cow - milk - pathway.** Kistner, G (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene); Wirth, E. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

In 1982 the waterphase of milk revealed a higher content of tritium than the waterphase of the environmental samples (rainwater, water of soil, and water of grass for feeding). We have not measured the tritium content in dry matter of the corresponding milk samples, but it can be seen from our investigations of amino acid fractions and fatty acids of milk that tritium is incorporated in a different manner, when it is taken up in form of HTO or by preformed organical compounds of plant material. Transfer factors of tritium in a multi-compartment system under dynamic conditions have to take into account the tritium content of the free water phase as well as the organical bound tritium. (orig.).

31433 (ISH–128, pp. 116-123) **Modelling of tritium in plants considering atmospheric releases from nuclear installations.** Strack, S. (Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Hauptabteilung Sicherheit/Radiooekologie). Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

To describe individual measurements in samples taken in the vicinity of nuclear installations, the specific activity model is evidently not suited. A dynamic model considering the real circumstances is needed for this purpose: For example the assessment of environmental impact from accidental releases from reprocessing plants. However, for assessments of the environmental impact of tritium in routine releases, the specific activity model (with some modifications) gives value convenient for work. (orig.).

31434 (ISH–128, pp. 124-128) **The use of Chernobyl fallout to quantify the transfer of submicron aerosols from rain to vegetation and test natural Be-7 as an environmental tracer.** Hoffman, F.O. (Oak Ridge National Lab., TN (USA). Environmental Sciences Div.); Larsen, I.L.; Frank, M.L.; Blaylock, B.G.; Olsen, C.R. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

Published in summary form only. TRANSFRONTIER CONTAMINATION/radioactive aerosols; RADIOACTIVE AEROSOLS/plants; SIMULATION; BERYLLIUM 7; RAIN; RADIOECOLOGICAL CONCENTRATION; CHERNOBYLSK-4 REACTOR; PLANTS; FALLOUT DEPOSITS; TRACER TECHNIQUES; DEPOSITION

31435 (ISH–128, pp. 129-153) **The use of Chernobyl fallout to test model predictions of the transfer of radioiodine from air to vegetation to milk.** Hoffman, F.O. (Oak Ridge National Lab., TN (USA). Environmental Sciences Div.); Amaral, E. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radiological assessment models, comparisons between predictions and observations. Proceedings.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

Comparison of observed values with model predictions indicate a tendency for the models to overpredict the air-vegetation-milk transfer of Chernobyl I-131 by one to two orders of magnitude. Detailed analysis of the data indicated that, in general, most overpredictions were accounted for by the portion of the air-pasture-cow-milk pathway dealing with the transfer from air to pasture vegetation rather than the transfer from vegetation to milk. A partial analysis using available data to infer site-specific conditions and parameter values indicates that differences between model predictions and observations can be explained by: (1) overestimation of the fraction of the total amount of I-131 in air that was present as molecular vapour, (2) overestimation of wet and dry deposition of elemental and organic iodine and particulate aerosols, (3) overestimation of initial vegetation interception of material deposited during sever thunderstorms, (4) underestimation of the rates of weathering and growth dilution of material deposited on vegetation during periods of spring growth, (5) underestimation of the amount of uncontaminated feed consumed by dairy cows, and (6) overestimation of the diet-to-milk transfer coefficient for I-131. (orig./HP).

31436 (ORNL/TM–11119) **Preliminary site survey report for the Uniroyal Chemical Company, formerly the Diamond Magnesium Company, 720 Fairport-Nursery Road, Painesville, Ohio (DMP001).** Foley, R.D.; Floyd, L.M. Oak Ridge National Lab., TN (USA). Mar 1990. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90010012. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted a preliminary radiological survey at the Uniroyal Chemical Company, formerly the Diamond Magnesium Company, 720 Fairport-Nursery Road,

Painesville, Ohio (DMP001), in 1988. The purpose of the survey was to determine whether the property was contaminated with radioactive residues from the former Manhattan Engineer District (MED) project. The scope of this preliminary survey primarily covered the area west of the buildings around the railroad car spill containment basin. The survey included direct measurement of gamma radiation levels at the surface and soil sampling for radionuclide analyses. Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria for both ^{238}U and ^{226}Ra in soil. Based on the results of this radiological assessment, it is recommended that a follow-up, detailed radiological survey of both surface and subsurface environs be performed to more precisely define the extent of the contamination. 5 refs., 10 figs., 3 tabs.

31437 (PB–90-153719/XAB) **Superfund Record of Decision (EPA Region 5): Big D Campground, Kingsville, OH. (First Remedial Action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 121p. (EPA/ROD/R–05-89/101). Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The Big D Campground site is in Kingsville, Ashtabula County, Ohio. The site consists of a 1.2-acre landfill created out of a former sand and gravel quarry. From 1964 to 1976 the site owner accepted approximately 28,000 cubic yards of hazardous materials for disposal which included up to 5,000 drums containing solvents, caustics, and oily substances. A 1986 remedial investigation identified the landfill as the primary source of contamination in soil outside the landfill and ground water underlying the landfill. Ground water contamination is of significant concern because it is migrating towards the drinking water supply wells of nearby residences and Conneaut Creek which is adjacent to and south of the site. The primary contaminants of concern affecting the soil and ground water are VOCs including PCE and TCE, other organics, and metals including chromium and lead. The selected remedial action for this site includes removing and incinerating up to 5,000 buried drums, bulk wastes, and up to 30,000 cubic yards of contaminated soil followed by onsite disposal of nonhazardous ash residue; pumping and treatment of 40,000,000 to 60,000,000 gallons of ground water.

31438 (PB–90-162603/XAB) **Superfund Record of Decision (EPA Region 8): Monticello Vicinity Properties, San Juan County, UT. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 35p. (EPA/ROD/R–08-89/025). Available from NTIS, PC A03/MF A01.

The Monticello Vicinity Properties site, also known as the Monticello Radiation Contaminated Properties, is a federally-owned abandoned vanadium and uranium mill area in the city of Monticello, San Juan County, Utah. Milling of vanadium and uranium occurred from 1944 to 1960. Currently, the site consists of a dismantled vanadium and uranium mill, and stabilized mill tailings piles. The Monticello Radiation Contaminated Properties were accepted into the Department of Energy's Surplus Facilities Management Program in 1980 for remedial action. The Vicinity Properties were formally included on the NPL in 1986 and, therefore, must comply with requirements of CERCLA. In October 1989 the Millsite itself was also listed on the NPL. DOE established an official list of Vicinity Properties designated for remedial action based on radiological surveys conducted from 1971 to 1984. As of March 1989, 91 properties had been identified to be included in the Monticello Vicinity Properties. Of these 91 properties, 53 remedial actions have been completed and 12 additional properties are slated for remedial action in 1989. The primary contaminants of concern in construction material and debris are thorium-230, radium-226, and radon-222 contained in the vanadium and uranium mill tailings.

31439 (PB–90-166141/XAB) **Proposed best demonstrated available technology (BDAT) addendum to the background document for K015. Volume 3.** Rosengrant, L.; Jones, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 31p. (EPA–530/SW-90/011C). Available from NTIS, PC A03/MF A01.

See also Volume 2, PB–90-166133, Volume 4, PB–90-166158 and PB–89-142350. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in K015 nonwaste waters and for developing proposed BDAT treatment standards for those regulated constituents. Treatment standards for K015 waste waters were originally promulgated as part of the 1st 3rds. The document is an addendum to the supporting BDAT background document for K015 dated August 1988. The addendum reflects only revisions pertaining to K015 nonwaste water standards development.

31440 (PB–90-166208/XAB) **Proposed best demonstrated available technology (BDAT) background document for K046 (addendum). Volume 9.** Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 51p. (EPA–530/SW-90/011I). Available from NTIS, PC A04/MF A01.

See also Volume 8, PB–90-166190, Volume 10, PB–90-166216 and PB–89-142442. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document, a proposed addendum to the 1988 background document, provides technical support for the treatment standards being proposed for K046 nonwaste waters in the reactive subcategory and for all K046 wastewaters. Waste waters are generally defined as wastes containing less than 1% (weight basis) total suspended solids and less than 1% total organic carbon. Wastes not meeting this definition are considered nonwastewaters.

31441 (PB–90-168063/XAB) **Characterization of contaminated soil from the Montclair/Glen Ridge, New Jersey, superfund sites.** Neiheisel, J. Office of Radiation Programs, Washington, DC (USA). Sep 1989. 61p. (EPA–520/1-89/012). Available from NTIS, PC A04/MF A01.

This report describes the soil characterization phase conducted at the EPA Eastern Environmental Radiation Facility (EERF) in Montgomery, Alabama. The identification of the spatial distribution of the radium within the soil and its association with specific minerals or materials is shown to relate to the later implementation phase. Procedures developed in the investigation have application to other radioactively contaminated Superfund sites.

31442 (PB–90-168493/XAB) **Sulfur accumulation and atmospherically deposited sulfate in the Lake states. Forest Service research paper.** David, M.B.; Gertner, G.Z.; Grigal, D.F.; Ohmann, L.F. Forest Service, St. Paul, MN (USA). North Central Forest Experiment Station. 1989. 10p. (FSRP-NC–290). Available from NTIS, PC A02/MF A01.

Also available from Supt. of Docs.

This report characterizes the mass of soil sulfur (adjusted for nitrogen), and atmospherically deposited sulfate along an acid-precipitation gradient from Minnesota to Michigan. The relationship of these variables, presented graphically through contour mapping, suggests that patterns of atmospheric wet sulfate deposition are reflected in soil-sulfur pools.

31443 (PB–90-172545/XAB) **Experimental study of natural-gas-fueled technologies for reduction of heavy-metal leachate from solid wastes. Topical report, January 1988-March 1989.** Newton, G.H.; Kramlich, J.C.; Seeker, W.R. Energy and Environmental Research Corp., Irvine, CA (USA). Jan 1989. 120p. Available from NTIS, PC A06/MF A01.

This study was concerned with evaluating thermal treatments of MSW fly ash intended to reduce the leachability of heavy metals in the fly ash. A review of the subject is given and current and potential treatments are evaluated in terms of economics and their ability to reduce heavy-metal leachability. Three treatments were considered: vitrification of the ash; encapsulating the ash in a surface-layer melt; and thermally binding the ash with clay. The extent of heavy metal volatilization during heating and the ability of the treatments to reduce leachability were evaluated. In addition to the experimental work, a combustion modification approach to controlling leachable metals which would reduce concentrations of leachable heavy-metal species was also evaluated theoretically.

31444 (PB–90-177858/XAB) **Superfund Record of Decision (EPA Region 7): Vogel Paint and Wax, Maurice, IA. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 20 Sep 1989. 47p. (EPA/ROD/R–07-89/027). Available from NTIS, PC A03/MF A01.

The Vogel Paint and Wax (VPW) site is an approximately two-acre disposal area two miles southwest of the town of Maurice, in Sioux County, Iowa. Adjacent land uses are primarily agricultural; however, several private residences are within one-quarter mile of the site. A surficial sand and gravel aquifer underlies the site and supplies nearby private wells and the Southern Sioux County Rural Water System, located a mile and one half southeast of the site. Paint sludge, resins, solvents, and other paint-manufacturing wastes were disposed of at the site between 1971 and 1979. VPW records indicate that approximately 43,000 gallons of aliphatic and aromatic hydrocarbons and 6,000 pounds of metals waste were buried at the site. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, toluene, and xylenes; and metals including chromium and lead. The selected remedial action for this site includes excavation of contaminated soil and separation of solid and liquid wastes; onsite bioremediation of 3,000 cubic yards of the contaminated soil in a fully contained surface impoundment unit, or onsite thermal treatment if soil contains high metal content; and stabilization of treated soil, if necessary to prevent leaching of metals, followed by disposal in the excavated area.

31445 (PB–90-178179/XAB) **Superfund Record of Decision (EPA Region 2): Pepe Field, Boonton, Morris County, New Jersey (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 51p. (EPA/ROD/R–02-89/091). Available from NTIS, PC A04/MF A01.

The Pepe Field site is a former disposal area in the town of Boonton, Morris County, New Jersey. From 1935 to 1950 the E.F. Drew Company used the site to dispose of wastes generated from processing vegetable oils and soap products. Materials reportedly deposited onsite by the E.F. Drew Company were diatomaceous earth and activated-carbon-filter residue; incinerator and boiler ash; boiler ash; lime sludge; and soap residue. Investigations revealed gas concentrations exceeding the lower explosive limit in the soil vapor at the perimeter of the site and in an apparent soil gas plume extending below the property adjacent to the site. The primary contaminants of concern affecting the soil found in the landfill include hydrogen sulfide and methane gases. The selected remedial action for this site includes maintaining the site cover; installing and maintaining a landfill gas-collection and treatment system using carbon adsorption; disposing of carbon offsite; upgrading and maintaining the existing leachage collection and treatment system; and ground water monitoring.

31446 (PB–90-178187/XAB) **Superfund Record of Decision (EPA Region 5): Auto Ion Chemicals, Kalamazoo, Michigan (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 59p. (EPA/ROD/R–05-89/103). Available from NTIS, PC A04/MF A01.

Portions of this document are not fully legible.

Auto Ion Chemicals site is a former plating waste-treatment and disposal facility occupying approximately 1.5 acres of vacant, fenced land in Kalamazoo, Michigan. Ground water at the site is not currently used as a source of drinking water. From 1964 to 1973 the facility received chrome and cyanide plating waste. Heavy metals were precipitated from the plating waste and deposited in an onsite lagoon, and waste water was discharged to the sanitary sewer. Leaks and spills from storage tanks, lagoon seepage, and other site activities resulted in soil contamination. In 1983, EPA conducted an emergency surface removal and, in 1986, they demolished the site structures which housed tanks and storage facilities. The selected remedial action for this site includes excavation and offsite stabilization of approximately 7,200 cubic yards of contaminated soil; offsite disposal of treated soil in an approved land-disposal area.

31447 (PB–90-178518/XAB) **Superfund Record of Decision (EPA Region 5): Industrial Excess Landfill, Inc., Uniontown, Ohio (Second remedial action), July 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 17 Jul 1989. 62p. (EPA/ROD/R–05-89/098). Available from NTIS, PC A04/MF A01.

See also PB–88-172994.

The 300-acre Industrial Excess Landfill site is in Uniontown, Stark County, Ohio. Several hundred residences are within a half mile of the site, and all residences and businesses in the Uniontown area rely on ground water from private-well supplies. The site was operated as a mixed industrial and refuse landfill from 1966 until 1980. Large amounts of fly ash and liquid wastes including latex and spent organic solvents were disposed of in the landfill between 1968 and 1972. In 1986 an active methane extraction system was installed to prevent the offsite migration of explosive levels of methane gas. In April 1987 EPA installed air strippers in eight residences and two businesses due to the presence of low levels of volatile organic compounds. In September 1987 EPA signed a Record of Decision (ROD) to provide an alternate water supply to 100 homes west of the site to ensure that the community received safe drinking water. The primary contaminants of concern affecting the soil, sediments, and ground water are VOCs including benzene, vinyl chloride, and PCE; other organics including carcinogenic PAHs; and metals.

31448 (PB–90-178526/XAB) **Superfund Record of Decision (EPA Region 6): Homestake Mining Company, Cibola County, New Mexico (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 62p. (EPA/ROD/R–06-89/050). Available from NTIS, PC A04/MF A01.

The Homestake Mining Company (HMC) site consists of a uranium-processing mill and two tailings embankments in Cibola County, New Mexico, about 6 miles north of Milan. The tailings embankments contain a combined total of 22 million tons of tailings material covering 225 acres. Four housing subdivisions are south and southwest of the mill with the nearest residence approximately 0.6 miles from the tailings embankments. In 1983 elevated levels of selenium were found in offsite ground water prompting EPA to require HMC, under a consent agreement, to supply municipal water to residents in the subdivision south of the mill. The restoration program continued to operate and has been largely successful in onsite containment of tailings seepage. EPA has determined that the uranium mill and tailings embankments at the site are not contributing significantly to offsite subdivision radon contamination and that it does not have authority under CERCLA to address radon levels due to natural soil concentrations.

31449 (PB–90-178864/XAB) **Superfund Record of Decision (EPA Region 8): Sand Creek Industrial, Commerce City, CO. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 85p. (EPA/ROD/R–08-89/024). Available from NTIS, PC A05/MF A01.

The Sand Creek Industrial site is in Commerce City, Adams County, Colorado. Land use in the vicinity of the site is industrial, including trucking firms, petroleum and chemical production and supply companies, warehouses, small businesses, and several residences. The site contains the property and buildings of the Colorado Organic Chemical Company (COC) and approximately 13 residences. Production wells north and downgradient of the study area are the source of water supply to the county. Pesticide manufacturing operations began at COC in the 1960s. Fires in 1968 and 1977 and improper pesticide-storage practices resulted in high levels of organophosphate pesticides, chlorinated hydrocarbons, and thermally-altered pesticides being released at the site. In 1978 COC removed some contaminated soil, and in 1984 COC removed drums of waste, excess product, and contaminated soil, and installed fencing at the site in response to an EPA order. The Record of Decision represents the first of five planned operable units for the site and addresses soil, buildings, and tanks contaminated by pesticides, volatile organics, and metals. The primary contaminants of concern affecting the soil, onsite buildings, and tanks are VOCs including TCE and PCE; and other organics including pesticides.

31450 (PB–90-178872/XAB) **Superfund Record of Decision (EPA Region 5): New Brighton/Arden Hills (TCAAP), Twin Cities Army Ammunition Plant, MN. (Seventh remedial action), August 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 11 Aug 1989. 36p. (EPA/ROD/R–05-89/118). Available from NTIS, PC A03/MF A01.

The New Brighton/Arden Hills site, also known as the Twin Cities Army Ammunition Plant (TCAAP) site, is in New Brighton, Minnesota. Past disposal of ammunition manufacturing wastes onsite resulted in contamination of ground water beneath and downgradient of the site. A total of 14 waste-disposal locations have been identified and assigned as Sites A through K. During remedial investigations at Site D, soil was discovered to be contaminated with PCBs and other organic and metal contaminants. A soil-gas extraction system was implemented to remove the source of volatile organic contamination and reduce the potential of migration to ground water. In implementing the soil gas extraction system, PCB-contaminated soil was removed, stockpiled near Site D, and sealed with a plastic-liner material. The interim remedy addresses the treatment and disposal of contaminated soil that is stockpiled near Site D. The primary contaminants of concern affecting the soil are VOCs including TCE and PCE, other organics including PCBs, and metals including arsenic and lead.

31451 (PNL–7200-Pt.2) **Pacific Northwest Laboratory annual report for 1989 to the DOE [Department of Energy] Office of Energy Research: Part 2, Environmental sciences.** Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 91p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90010188. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report summarizes progress in environmental sciences research conducted by Pacific Northwest Laboratory (PBL) for the Office of Health and Environmental Research in FY 1989. Research is directed toward developing a fundamental understanding of processes controlling the long-term fate and biological effects of fugitive chemicals and other stressors resulting from energy development. The report is organized by major research areas. Within this division, individual reports summarize the progress of projects in these areas. Additional sections summarize exploratory research, educational institutional interactions, technology transfer, and publications. The research, focused principally on subsurface contaminant transport and detection and management of human-induced changes in biological systems, forms the basis for defining and quantifying processes that affect humans and the environment at the local, regional, and global levels.

31452 (RISO-M–2831) **Transfer of radiocaesium to barley, rye grass and pea.** Oehlenschlaeger, M.; Gissel-Nielsen, G. Risoe National Lab., Roskilde (Denmark). Nov 1989. 20p. Contract B16-PC-267-DK. Order Number DE90626526. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In areas with intensive farming, as in Denmark, it is of great interest to identify possible countermeasures to be taken in order to reduce the longterm effects of radioactive contamination of arable land. The most important longer-lived radionuclides from the Chernobyl were ^{137}Cs and ^{134}Cs. The aim of the present project was to identify crops with relatively low or high root uptake of these two isotopes. Although such differences may be small, a shift in varieties might be a cost-effective way to reduce collective doses. The experiment was carried out at Risoe National Laboratory in the summer of 1988. The species used were: spring barley (Hordeum vulgare L) varieties: Golf, Apex, Anker, Sila; Perennial rye grass (Lolium perenne L.) varieties: Darbo (early) and Patoro (late); Italian rye-grass (Lolium multiflorum) variety: Prego; and pea (Pisum arvense L.) variety: Bodil. Each crop was grown in two types of soil, a clay-loam and an organic soil. ^{137}Cs was added to the clay-loam. The organic soil, which was contaminated with ^{137}Cs from the Chernobyl accident, was supplied with ^{134}Cs. Sila barley and Italian rye-grass were identified among the species tested as plants with a relative high uptake of radio-caesium. (author).

31453 (RISO-R–564) **Environmental radioactivity in the North Atlantic region including the Faroe Islands and Greenland. 1987.** Aarkrog, A.; Buch, E.; Chen, Q.J.; Christensen, G.C.; Dahlgaard, H.; Hansen, H.; Holm, E.; Nielsen, S.P. (eds.). Risoe National Lab., Roskilde (Denmark). Health Physics Dept. Jul 1989. 84p. Order Number DE90626525. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Measurements of fallout radioactivity in the North Atlantic region including the Faroe Islands and Greenland are reported. Strontium-90, cesium-137 and cesium-134 were determined in samples of precipitation, sea water, vegetation, various foodstuffs (including milk in the Faroes), and drinking water. Estimates are given of the mean contents of ^{90}Sr and ^{137}Cs in human diet in the Faroes and Greenland in 1987. ^{99}Tc data on marine samples are reported. Data on plutonium and americium in sediments and biota collected at Thule in 1984 are presented. (author) 102 tabs., 35 ills., 15 refs.

31454 (SNV–3575) **Radionuclides in perch from the biotest basin at the nuclear plant at Forsmark.** Notter, Manuela (Statens Naturvaardsverk, Oeregrund (Sweden). Laboratoriet foer Miljoekontroll). Statens Natuurvaardsverk, Solna (Sweden). 1989. 44p. (In Swedish). Order Number DE90626503. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Samples of about twenty three-years-old females of perch were taken monthly. The fish were dissected and pooled samples of muscle, liver, digestive tissues, gonads and remaining parts were made. The stomach content was also analysed. The prey animals were also sampled. Several nuclides were detected. The nuclides Co-60, Zn-65, Cs-137, Cs-134 and K-40 were relatively frequently found in all analysed fish organs. In this report, Co-60, Zn-65 and Cs-137 are specially considered. The highest Co-60 concentration was found in liver (180 Bq/kg f.w.) whereas muscle had the lowest values (3 Bq/kg f.w.). The concentration of Co-60 in the digestive tissues and the total 'body burden' of Co-60 was correlated to the accumulated discharge on year before sampling. The Zn-65 concentration had about the same value (60 Bq/kg f.w.) in all the studied organs exept for the concentration in muscle which was lower (6 Bq/kg f.w.). In liver and digestive organs, the Zn-65 concentration was correlated to the accumulated disharge 3-6 months before fish sampling. The 'body burden' of Zn-65 was correlated to the accumulated discharge (6 months before sampling). The Cs-137 concentrations were nearly the same (280 Bq/kg) in all the investigated tissues. A relatively large part (38%) of the Cs-137 'body burden' is located to the fish muscle, a very important organ in dose commitment calculations. The concentrations of Co-60 and Zn-65 in the prey animals are, for most species, correlated to the discharge from the nuclear power plant. (20 figs., 5 tabs., 19 refs.).

31455 (SSI–89-09) **Local reference measurements of gamma radiation - advice and comments.** Wallin, Mauritz. National Inst. of Radiation Protection, Stockholm (Sweden). 10 Jul 1989. 22p. (In Swedish). Order Number DE90626285. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report is a manual for measuring local gamma radiation levels. Instructions are given how the instruments (GM-tubes) should be employed in outdoor measurements. The importance of makin reference, background, measurements is pointed out. (L.E.).

31456 (WSRC-RP–89-1288) **October 1, 1989 tornado at the Savannah River Site.** Parker, M.J.; Kurzeja, R.J. Westinghouse Savannah River Co., Aiken, SC (USA). Jan 1990. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90008218. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A tornado with wind speeds in the 113 to 157 mph range struck the southern portion of the Savannah River Site near Aiken, SC at around 7:30 pm on October 1, 1989. The tornado was spawned from a severe thunderstorm with a height of 57,000 ft in a warm and humid air mass. Two million dollars in timber damage occurred over 2,500 acres along a ten-mile swath, but no onsite structural damage or personal injury occurred. Tree-fall patterns indicated that some of this damage was the result of thunderstorm downbursts which accompanied the tornado. Ground-based and aerial photography showed both snapped and mowed over trees which indicate that the tornado was elevated at times. 4 refs., 25 figs., 2 tabs.

31457 Characterization of phosphorus in sludge extracts using phosphorus-31 nuclear magnetic resonance spectroscopy. Hinedi, Z.R. (Univ. of California, Riverside (USA));

Chang, A.C.; Lee, R.W.K. *Journal of Environmental Quality (USA)*, 18(3): 323-329 (Jul-Sep 1989).

Nuclear magnetic resonance spectroscopy (^{31}P NMR) was used to characterize the phosphorus (P) extracted from selected municipal sewage sludges. Aqueous and nonaqueous extraction schemes were studied. The trichloroacetic acid/KOH two-step extraction and the 0.5 M NaOH extraction were effective in recovering P from sludges. It was found that the P distribution pattern is sludges was affected by the sludge digestion processes. Almost all of the P in anaerobically digested sludges was inorganic. In the waste-activate sludge and aerobically digested sludges, more than 50% of the total P was present as P-monoesters and P-diesters. Several experiments were conducted to confirm P-diester peak assignment. Incubation of the sludge with ribonuclease caused a decrease of the peak in the P-diester region, indicating that at least a part of the P-diesters is in the form of RNA. Results of a dialysis experiment appeared to indicate that P-diesters were broken down from the molecular weight >1000 material to their lower molecular weight components during sludge digestion. The peaks appearing in the ^{31}P NMR spectra of sludge-borne phospholipids were tentatively assigned to phosphatidylcholine, phosphatidylserine, phosphatidylethanolanmine, and phosphatidylglycerol or diphosphatidylglycerol.

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Refer also to citation(s) 29985, 29998, 30003, 30004, 30008, 30066, 30067, 30068, 30069, 30134, 30137, 30138, 30216, 30364, 30378, 30891, 30892, 30914, 30923, 31348, 31357, 31371, 31384, 31387, 31416, 31417, 31423, 31427, 31430, 31437, 31444, 31445, 31446, 31447, 31448, 31451, 31558, 31577, 31624, 31636

31458 (AD-A-217108/0/XAB) **Pollution Hazard Assessment System: Documentation and users manual. Final report, January 1988-September 1989.** Small, M.J. Army Biomedical Research and Development Lab., Fort Detrick, MD (USA). 1 Oct 1989. 10p. (USABRDL-TR-9003). Available from NTIS, PC A02/MF A01.

The preliminary pollutant limit value approach has been used to assess soil and water contamination at several U.S. Army installations. This report documents the adaptation of this approach into a software computer package, the Pollution Hazard Assessment System (PHAS). PHAS, programmed in BASIC code, is capable of being handled on many personal computer configurations and can be supported with a system with 640K memory, two-disk drives, a monochrome monitor, and a line printer. PHAS has been prepared in modular form. The user is guided through the system with menu displays in user-friendly format. The user can prepare information for immediate analysis, or store information in off-line files for recall. Files can be recalled for analysis or modification. Three set of user files are employed: files which store information about scenario pathways of human exposure; files which store data about human intake, livestock characteristics (for human consumption of beef or milk), and site-specific factors; and files which store information about chemical-specific properties. The user can select up to 8 exposure pathways for water-based contamination problems. A chemical estimation module is provided to assist in developing data for chemicals. This module can be used in conjunction with the rest of the system or as a stand-alone routine. The main test provides the user with system instructions as well as a public health risk assessment.

31459 (AD-A-217258/3/XAB) **Review and synthesis of bioassessment methodologies for freshwater contaminated sediments. Final report.** Dillon, T.M.; Gibson, A.B. Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Environmental Lab. Jan 1990. 36p. (WES/MP/EL-90-2). Available from NTIS, PC A03/MF A01.

This report presents the results of a review of various bioassessment methods for evaluating the biological effects of in-place contaminated sediments. Promising methodologies are identified with a particular emphasis on those tests which have been developed to the point where incorporation into regulatory programs is feasible. A generic tiered-testing protocol to guide the conduct of these tests is presented.

31460 (AD-A-217259/1/XAB) **New Bedford Harbor Superfund Project, Acushnet River estuary engineering feasibility study of dredging and dredged-material disposal alternatives. Report 12. Executive summary. Final report.** Averett, D.E.; Otis, M.J. Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Environmental Lab. Jan 1990. 42p. (WES/TR/EL-88-15-12). Available from NTIS, PC A03/MF A01.

See also Report 11, AD-A211 895.

Sediments in New Bedford Harbor, Massachusetts, have been contaminated with polychlorinated biphenyl compounds and heavy metals. The high levels of contamination have resulted in the New Bedford site being placed on the National Priorities List of the Nation's worst hazardous waste sites. The US Army Corps of Engineers has been working since 1986 in efforts to evaluate remedial action alternatives for this site. The purpose of the EFS was to evaluate the engineering feasibility of dredging and selected disposal alternatives for removal and disposal of contaminated sediment from the New Bedford Superfund Site. Results of the EFS are presented in a series fo 12 reports. Reports 1-11 present detailed results of field investigations, laboratory studies, and engineering analyses. This executive summary highlights information from the first 11 reports and presents results of the EFS.

31461 (AD-A-217509/9/XAB) **Installation-restoration program (IRP). Stage 3. McClellan AFB, California remedial investigation/feasibility study ground-water sampling and analysis program. Final report, 1 August 1979-31 December 1988.** Radian Corp., Sacramento, CA (USA). 8 Nov 1989. 1116p. Available from NTIS, PC A99/MF E09.

Includes 7 Folders with Charts.

This Annual Technical Report presents the interpretive results for analytical and hydrologic data during ground-water sampling and analysis activities at McClellan AFB from August 1979 through December 1988. The data are used to evaluate the occurrence and migration of ground-water contaminants, to assess uncertainty in the sampling and analytical processes, to identify any hydrologic and analytical trends developing over time and to evaluate the effectiveness of the Area C and Area D extraction systems. The analytical data were reviewed in terms of specific Quality Assurance and Quality Control procedures. The analytical data were found to meet and exceed QA/QC objectives. Uncertainties due to sampling and analytical variability were calculated for 8 analytes and were found to be less than 30%. In Area A, contaminants have been detected in the existing wells but the extent of groundwater contamination cannot be determined. In Area B, pumping of on- and off-base water supply wells appears to be the dominant factor affecting ground-water flow directions and contaminant migration. In Area C, the main direction of contaminant migration has been to the south, following the regional ground-water flow direction. In Area D the extraction systems appears to be working effectively to control ground-water flow and prevent off-base migration of contaminants.

31462 (AD-A-217636/0/XAB) **Biological treatment of composition B waste waters. 2. Analysis of performance of Holston Army Ammunition Plant waste-water treatment facility, January 1985 through August 1986. Technical report, January 1986-December 1987.** Dickinson, W.; Paulson, E.T.; Carnahan, R.P. Army Biomedical Research and Development Lab., Fort Detrick, MD (USA). 18 Aug 1988. 114p. (ABMRDL-TR-8806). Available from NTIS, PC A06/MF A01.

The U.S. Army Biomedical Research and Development Laboratory has conducted a study of the operation of the industrial liquid waste treatment facility at Holston Army Ammunition Plant (HSAAP) from startup in 1983 through August 1986. The HSAAP waste treatment plant includes anoxic denitrification filters, a trickling filter, activated sludge treatment, and dual media filtration, and currently receives about 5 mgd of process wastewaters containing moderate chemical oxygen demand and nitrate levels and low, but significant, levels of RDX, HMX and nitramine coproducts. Daily performance and operational parameters have been compiled and analyzed, and the overall efficiency of the treatment scheme has been evaluated. It is concluded that this treatment facility is adequate for HSAAP for the foreseeable future, but does not represent the best choice for a new RDX facility elsewhere.

31463 (AERE-R–13448) **Studies of environmental radioactivity in Cumbria. Pt. 17: A revised basis for modelling radionuclide dispersion in the Irish Sea.** Howorth, J.M. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. Mar 1989. 49p. Available from H.M. Stationery Office, London, price Pound 10.00.

A 2-dimensional numerical model is used at Harwell to simulate the dispersion of Sellafield-derived radionuclides through the Irish Sea. This report summarizes recent developments and changes to that model. The two principal developments have been the extension of the model grid to cover a larger area and the use of flow rates derived from a hydrodynamic Continental Shelf model. In consequence, substantially better validation of the model has been achieved and earlier discrepancies with $^{239+240}Pu$ measurements are now confined to a small area in the immediate vicinity of the discharge point. Good agreement is reached with spatial and temporal distributions of ^{137}Cs, $^{239+240}Pu$, ^{241}Am. The marine model forms the first part of a suite of models to assess the radiological impact of the transfer of radionuclides to land in seaspray. The revisions to the marine model will have no impact on calculated doses to the hypothetical 'critical group'. However, doses to the average person will decrease slightly less rapidly than indicated by previous calculations. (author).

31464 (BR–89(22)) **Marsh management in coastal Louisiana: Effects and issues: Proceedings of a symposium.** Duffy, W.G. (National Wetlands Research Center, Slidell, LA (USA)); Clark, D. (eds.). Fish and Wildlife Service, Washington, DC (USA); Louisiana Dept. of Natural Resources, Baton Rouge, LA (USA). Coastal Management Div.; National Wetlands Research Center, Slidell, LA (USA). Sep 1989. 378p. Sponsored by U.S. Department of the Interior. (CONF-8806468–: Symposium on marsh management in coastal Louisiana, Baton Rouge, LA (USA), 7-10 Jun 1988). Available from OSTI; US Fish and Wildlife Service, NASA-Slidell Computer Complex, 1010 Gause Boulevard, Slidell, LA 70458.

The marshes of coastal southeast Louisiana occur over an area that constitutes about 60% of the Mississippi River Deltaic Plain complex, the newest land added to the Gulf Coastal Region during the past few thousand years. Part 1 of this paper consists of a brief description of the deltaic plain complex. Part 2 is concerned with the description of the coastal bays, sounds, transgressive barrier islands, and offshore shoals which are related to the delta complex. Part 3 discusses 51 significant papers on the delta complex which have been written during the past 58 years. Part 4 is a brief summary of the origin and development of the coastal region of southeast Louisiana based upon the research outlined above. Illustrations show how the mighty Mississippi River created about 14,000 mi^2 of new land in the Gulf of Mexico, in the form of a series of deltas, during the past 7,000 years. Attention is also subsidence of abandoned delta sediments, which permitted the gulf to move in inland and reclaim about 7,000 mi^2 of this new land. This volume contains 37 papers. Individual papers are indexed separately on the energy data base.

31465 (CNIC–00205) **Survey and assessment of levels of natural uranium in Yangtze River water.** Liu Yulan (Ministry of Public Health, Beijing, BJ (China). Lab. of Industrial Hygiene); Shi Zhongxin. China Nuclear Information Centre, Beijing, BJ (China). Apr 1988. 9p. (In Chinese). (LIHMPH–0001). Order Number DE90626328. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The uranium content in water and fish in Yangtze River is determined in 1979, 1980. The results of U content are given, it shows a change trend from high to low in U content from upper to lower. The average in the dry water period is higher than the rich water period, the range is $(0.15 \approx 4.21) \times 10^{-2}$ Bq/L and $(0.13 \approx 3.06) \times 10^{-2}$ Bq/L respectively. Total average is 2.04×10^{-2} Bq/L, lower than standard limit in China. The average of U content is 4.18×10^{-2}Bq/kg in fish meat. There is great difference of U content among various fishes, the highest value is 9.44×10^{-2}Bq/kg, the lowest is 1.60×10^{-2}Bq/kg in fish meat. The U cumulative coefficient for various species of fish, the highest value is 4.5, the lowest is 0.53, but the U content in all fishes determined is below standard limit of foodstuffs radiation in China. The results of dose estimation and annual intake by inhabitant show that is below UNSCEAR report 1986.

31466 (CONF-891210–3) **Assessing impacts of potential accelerating sea-level rise on coastal energy facilities, USA.** Harrison, W. (Argonne National Lab., IL (USA)); Santini, D.J.; Aubrey, D.G. Argonne National Lab., IL (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 9. Miami international congress on energy and environment; Miami Beach, FL (USA); 11-13 Dec 1989. Order Number DE90010420. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The combination of worldwide (eustatic) sea-level rise (SLR) and local SLR due to consolidation of sediments or downward crustal movement is termed "relative SLR" (RSLR). Recent studies indicate that the eustatic component of RSLR may accelerate in the years ahead due to climate warming. This eustatic SLR will be augmented by ongoing consolidation of sediments and crustal subsidence along numerous stretches of the Atlantic and Gulf coasts of the United States, with attendant threats to existing and planned energy facilities. This paper provides a strategy for estimating the costs that could be incurred under various SLR scenarios for such facilities as electric generating stations, petroleum refinery/storage facilities, chemical plants, steel mills, and oil and liquefied natural gas port facilities. 15 refs., 3 figs.

31467 (CONF-900275–2) **Use of a small minisodar to measure tributary drainage flow during ASCOT [Atmospheric Studies in COmplex Terrain] 88.** Coulter, R.L.; Martin, T.J. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 5. international symposium on acoustic remote sensing of the atmosphere and oceans; New Delhi (India); 6-9 Feb 1990. Order Number DE90010086. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The contribution of tributary flow to the strength, amount, and dynamics of valley drainage flow is an important part of the Atmospheric Studies in Complex Terrain (ASCOT) program. The ASCOT campaign in 1988 was designed to evaluate the relative drainage effectiveness of valleys with different shapes and orientations to the mesoscale wind direction. A part of this campaign was devoted to the investigation of the relative importance of different tributaries to a single main valley drainage system. It was necessary to measure wind profiles in as many locations as possible. To facilitate this effort, a very small minisodar was developed and used. The techniques and instrument developed for this purpose and some of the results are discussed in this paper.

31468 (DOE/ER/12018–T8) **Groundwater contamination: Studies in geophysics.** National Research Council, Washington, DC (USA). Geophysics Study Committee. 1984. 179p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010450. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This study is part of a series of studies in geophysics that have been undertaken for the Geophysics Research Forum by the Geophysics Study Committee. One purpose of each study is to provide assessments from the scientific community to aid policymakers in decisions on a societal problem that involve geophysics. An important part of such assessments is an evaluation of the adequacy of current geophysical knowledge and the appropriateness of current research programs as a source of information required for those decisions. The study addresses our current scientific understanding of groundwater contaminant transport — both by theory and by investigation of contaminated aquifers. The study also looks at many of the fundamental questions and uncertainties that require additional scientific research for the prediction of contaminant transport and the control of groundwater contamination. This volume contains 14 papers. Individual papers are indexed separately on the energy data base.

31469 (DOE/ER/12018–T13) **Scientific basis of water-resource management: Studies in geophysics.** National Academy of Sciences - National Research Council, Washington,

DC (USA). Geophysics Research Board. 1982. 127p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Academy of Sciences/National Academy of Engineering/Institute of Medicine; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; U.S. Geo DOE Contract FG01-82ER12018;FG01-80ER10757. Order Number DE90010505. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This volume contains 11 reports regarding water-resource management. Topics include: long-term and large-scale problems of water management, such as groundwater contamination due to toxic and nuclear-waste disposal; nonpoint sources of pollution on our stream systems; impacts of changes in both flow and water quality on the aquatic ecosystem; the frequency, duration, and impacts of droughts including long-term trends toward desertification; long-term hydrologic budgets for assessing the adequacy of regional or national water resources; global geochemical cycles such as the fate of nitrogen and sulfur; and protection of engineered systems against hydrologic extrema. These macroscale and long-term problems, involving large investments and the health and well-being of much of the world's population, demand increasingly precise and accurate predictive statements. Individual reports are indexed separately on the energy data base.

31470 (DOE/ER/12018–T18) **Fundamental research on estuaries: The importance of an interdisciplinary approach: Studies in geophysics.** National Research Council, Washington, DC (USA). Geophysics Study Committee. 1983. 79p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018;FG01-81EV10452;FG01-80ER10757. Order Number DE90010510. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

In 1974 the Geophysics Research Board completed a plan, for a series of studies to be carried out on various subjects related to geophysics. One purpose of the studies is to provide assessments from the scientific community to aid policymakers in decisions on societal problems that involve geophysics. An important part of such an assessment is an evaluation of the adequacy of present geophysical knowledge and the appropriateness of present research programs to provide information required for those decisions. This study examines the need for basic research to understand estuarine processes. The major unanswered questions relate to the interrelationships of estuarine circulation, biota, geology, and chemistry, where an interdisciplinary coordinated effort will be necessary. The areas were organized around a traditional disciplinary facet of estuaries but focused on the interdisciplinary needs. 58 refs., 11 figs., 1 tab.

31471 (DOE/OR/21864–4) **St. Charles County well field monitoring project: Quarterly report, January–March 1990.** Remington, S.M. Saint Charles County Water Dept., St. Charles, MO (USA). 1990. 58p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract FG05-89OR21864. Order Number DE90010626. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The yearly chemical analyses on all the St. Charles County productions wells, the observation wells, and all of the Department of Energy wells, were not taken in January because the DOE did not get final approval for their new contract for analyses. Instead the regular monthly samples were taken. The results from the sampling done on December 18, 1989 were received from MetaTrace. They are appended. The well sampled was RMW-2. All the results were normal with either no detections or figures which did not deviate from prior readings to any large degree.

31472 (DOE-RW–89.065) **Studies of environmental radioactivity in Cumbria - Pt. 19: Possible influence of tributyl phosphate on aerosol generation in Cumbrian coastal waters.** McKay, W.A. (UKAEA Harwell Lab. (UK). Environmental and Medical Science Div.); Walker, M.I.; Szweda, C. Department of the Environment, London (UK). Apr 1989. 21p. (AERE-R–13468). Order Number DE90626329. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Final report.

Laboratory experiments were performed to investigate the effect of increased concentrations of the surface active organic solvent tributyl phosphate (TBP), on the size of bubbles generated in saline solutions and on the magnitude of the resulting aerosol flux. The results are preliminary but suggest that TBP though highly enriched in aerosol is unlikely to have had an observable effect on aerosol flux to the Cumbrian coast either in the past or present due to the presence of relatively high levels of other surface active organics in Irish Sea waters. (author).

31473 (EC/NHRIS–88018) **Shallow ice borehole logger and deployment system.** Demuth, M.N. (Surface Water Div., Environment Canada, Saskatoon, SK (Canada)); Holdsworth, G.; Brancker, R. Environment Canada, Saskatoon, SK (Canada). National Hydrology Research Inst. 1988. 24p. (MICROLOG–90-02386). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

An improved shallow ice-borehole logging system was developed to complement the ice-core drilling activities associated with the Climate Change and Ice-Core Chemistry projects. The system is capable of logging dry boreholes up to 200 m deep and may be easily transported and assembled by its 2 operators. A number of geometric and physical parameters are measured for use in studies of glacier ice rheology and deformation. The significance of conducting glacier deformation measurements in conjunction with core retrieval is summarized with special reference to climate change research. 5 refs., 3 figs.

31474 (EC/NWRI–90-01262) **Reflections 1988-89: National Water Research Institute: Executive director's report.** Environment Canada, Burlington, ON (Canada). National Water Research Inst. [1990]. 35p. (MICROLOG–90-01262). Available from PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Environment Canada's National Water Research Institute (NWRI) conducts a national program of research and development in the aquatic sciences. This report provides a selection of highlights representative of the Institute's work related to the themes of international participation and the contribution of science to decision-making. Some of these highlights involved participation in the World Conference on the Changing Atmosphere in June 1988; NASA's Global Troposphere Experiment in which the fluxes and concentrations of methane and other gases are measured over the Hudson Bay Lowland; a study on the fate and effects of chemicals from tar sands plants on the Athabasca River in Alberta; a forum on the priority substances list, a list of 44 substances which must undergo a formal assessment within 5 years to determine whether each should be regulated under the Canadian Environmental Protection Act; and recommendations at a workshop on the place of biological testing in hazard assessment and regulatory control.

31475 (FO–90-02160) **Atlas of physical oceanographic data for current surge studies on the Grand Bark of Newfoundland, 1985.** Canadian technical report of hydrography and ocean science, no. 121. Sandstrom, H. (Physical and Chemical Sciences Branch, Dept. of Fisheries and Oceans, Dartmouth, NS (Canada)); Elliott, J.A. Department of Fisheries and Oceans, Ottawa, ON (Canada). Apr 1989. 472p. (MICROLOG–90-02160). Available from PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6, MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This is the fourth in a series of atlases prepared to study the incidence of tidally generated large amplitude internal waves and associated current surges along east coast continental shelves. This atlas covers CSS DAWSON cruise 85-024 to the edge of the Grand Banks in the vicinity and to the east of the Hibernia exploration area. The field data were collected near the shelf edge and extending into Flemish Pass centered on 47 N latitude from August 13-28, 1985. Two moorings were deployed and recovered. CTD, BATFISH, Ametek Straza Acoustc Doppler Current Profiler, and 12 kHz Raytheon Sounder equipment were operated from the ship. SLAR (Side Looking Aperture Radar) flights during the summer of

1984 had indicated the presence of groups of high amplitude internal waves near the shelf edge, similar to those on the Scotian Shelf studied during earlier cruises. This cruise studied the nature of the internal tide and the short waves and compared the process to that in the Scotian Gulf and near the Gully, being cognizant of the contrasting density profiles and bathymetry. 5 refs, 451 figs.

31476 (FO–90-02285) **The distribution of petroleum residues in near-shore sediments from Atlantic Canada.** Canadian technical report of fisheries and acquatic sciences, no. 1612. Levy, E.M. (Bedford Institute of Oceanography, Darmouth, NS (Canada)); Lee, K.; Saunders, K.S.; Cobauli, S.E. Department of Fisheries and Oceans, Ottawa, ON (Canada). Mar 1988. 173p. (MICROLOG–90-02285). Available from PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Data from a survey of the concentrations of petroleum residues in sediments from harbours in Atlantic Canada in 1978 were compiled. Petroleum residues are defined as the mixture which remains after petroleum-derived oils are subjected to varying amounts of weathering in the marine environment in sediments from harbours in Atlantic Canada. The survey collected sediment samples from as many harbours in the region as possible, covering the entire range of geological environments, industrial areas (oil refining, shipping, fishing, fish processing, steel-making, manufacturing), and the populated rural settings to be found in the region. The sampling program was carried out in late 1978, prior to freeze-up and some samples were analyzed in early 1979, with the remainder analyzed in 1987. Statistical analysis indicates that of the samples collected from 65 diverse localities, the mean petroleum residue concentration was 22.9 μ/g (range: 019-1145 μ/g). Of the 27 ports with mean petroleum residue concentrations below 10 μ/g (the regulated limit defined by the Ocean Dumping Control Act, based on gravimetric analyses of n-hexane soluble substances) none were major industrial/residential centers. Elevated concentrations of petroleum residues were usually associated with harbours having oil refineries, industrial activities, and centers of dense population and, in most cases, such contamination could be directly attributed to an obvious local source. 6 refs., 55 figs., 65 tabs.

31477 (ISH–128, pp. 43-74) **Assessment of doses to man from liquid releases of ^{60}Co. Important pathways and transfer parameters.** Zeevaert, T.; Kirchmann, R.; Vandecasteele, C.M. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Jan 1989. (CONF-8611306–: Workshop in radioecology, Neuherberg (Germany, F.R.), 5-7 Nov 1986). In *Experiences with radioecological assessment models, comparisons between predictions and observations.* Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

The important pathways of exposure of man due to liquid discharges of Co-60 in fresh water systems (e.g. rivers) were identified and experiments have been carried out to quantify some important transfer factors. Pathways, for which the bed sediment acts as a transfer compartment, (manuring with sediment) or as an end compartment (external irradiation on the river banks), proved to be very important for liquid discharges containing Co-60. The direct irradiation by the sediment on the river banks was shown to constitute the major exposure pathway for the critical individual. Observed values were available for: Distribution coefficient, fresh water fish concentration factor, aquatic plants concentration factor, soil-to-plant transfer factor, milk and meat transfer factors, sedimentation constant, bed sediment velocity. The substitution of default transfer parameters values by the observed ones gave rise to important changes of the calculated concentrations in food crops, manured with sediment or aquatic plants (increase) and in milk and meat (decrease). For routine releases, apart from the external irradiation by the sediment, the highest first year dose was brought about by the irrigation of grain, whereas the manuring of root crops with sediment gave rise to the highest dose at equilibrium. The dose values for accidental releases depended very much on the moment of the year at which the release occurs. The highest first year dose was brought about by the ingestion of irrigated grain, when the release occurred at the end of the irrigation period. (orig./HP).

31478 (PB–90-162637/XAB) **Superfund Record of Decision (EPA Region 7): Solid State Circuits, Republic, MO. (First remedial action) September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 125p. (EPA/ROD/R–07-89/026). Available from NTIS, PC A06/MF A01.

The Solid State Circuits (SSC) site, a former industrial and manufacturing facility, is located in Republic, Missouri, approximately twelve miles southwest of Springfield. The city of Republic obtains its drinking water from three municipal wells which draw from the deepest of three underlying aquifers. Uses of the facility since 1902 included milling, refrigeration, printed circuit board manufacturing, and photoprocessing, as well as other, unknown, activities. The major wastes generated appear to have been cleaning solvents used in the circuit board process and wastewaters from the circuit board activities. Sampling by the Missouri Department of Natural Resources (MDNR) in 1982 revealed contamination with TCE in Municipal Well Number 1, 500 feet south of the site. The SSC site was identified as a possible source. Subsequent actions included pumping tests, several major soil and debris excavations and removals (thereby eliminating the source of contamination), and taking Municipal Well Number 1 out of service. The primary contaminants of concern are VOCs, particularly TCE.

31479 (PB–90-166117/XAB) **Proposed best demonstrated available technology (BDAT) (26 volumes).** Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 1843p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-166125 through PB–90-166372.

A separate abstract is included for each of the 26 volumes of this set.

31480 (PB–90-166125/XAB) **Proposed best demonstrated available technology (BDAT) background document for K031, K084, K101, K102, characteristic arsenic wastes (D004), characteristic selenium wastes (D010), and P and U wastes containing arsenic and selenium listing constitutents. Volume 1.** Rosengrant, L.; Craig, R. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 105p. (EPA–530/SW-90/011A). Available from NTIS, PC A06/MF A01.

See also Volume 2, PB–90-166133 and PB–89-142459. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

The background document presents the technical support and rationale for developing regulatory standards for K031, K084, K101, K102, D004, D010 and P and U wastes. Section 1 presents available data regarding the industries affected by the land disposal restriction, brief descriptions of the waste-generating processes, and waste characterization data. Section 2 discusses the technologies used to treat the wastes; Section 3 presents available treatment performance data; Section explains EPA's determination of BDAT; Section 5 discusses the selection of constituents to be regulated; and Section 6 determines the proposed treatment standards.

31481 (PB–90-166133/XAB) **Proposed best demonstrated available technology (BDAT) background document for characteristic ignitable wastes (D001), characteristic corrosive wastes (D002), characteristic reactive wastes (D003), and P and U wastes containing reactive listing constituents. Volume 2.** Rosengrant, L.; Craig, R. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 177p. (EPA–530/SW-90/011B). Available from NTIS, PC A09/MF A01.

See also Volume 1, PB–90-166125 and Volume 3, PB–90-166141. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the technical support for selecting and developing the treatment standards for D001, D002, D003 and P and U wastes containing reactive-listing constituents. Section 1 presents waste-specific information such as the waste-generating processes and waste characterization. Section 2 describes the industries that will be affected by the land-disposal

restrictions for the specific characteristic waste; Section 3 discusses the applicable technologies that can be used to treat the waste; and Section 4 identifies the BDAT.

31482 (PB–90-166158/XAB) **Proposed best demonstrated available technology (BDAT) background document for K073. Volume 4.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 71p. (EPA–530/SW-90/011D). Available from NTIS, PC A04/MF A01.

See also Volume 3, PB–90-166141 and Volume 5, PB–90-166166. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support for selecting and developing the proposed treatment standards for the constituents to be regulated in K073 waste. The document explains how EPA determines BDAT, selects constituents for regulation and calculates treatment standards. Section 2 presents waste-specific information–the number and location of facilities affected by the land-disposal restrictions, the waste-generating process, and waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which the proposed treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. The treatment standards are determined in Section 7.

31483 (PB–90-166174/XAB) **Proposed best demonstrated available technology (BDAT) background document for K086 (ink-formulation equipment-cleaning wastes) (Addendum). Volume 6.** Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 37p. (EPA–530/SW-90/011F). Available from NTIS, PC A03/MF A01.

See also Volume 5, PB–90-166166, Volume 7, PB–90-166182 and PB–89-142483. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the additional data and analyses that are the support for the proposed K086 treatment standards. The background document is an addendum to the August 1988 background document for K086 solvent wash.

31484 (PB–90-166182/XAB) **Proposed best demonstrated available technology (BDAT) background document for K060. Volume 7.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 57p. (EPA–530/SW-90/011G). Available from NTIS, PC A04/MF A01.

See also Volume 6, PB–90-166174 and Volume 8, PB–90-166190. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for selecting and developing the proposed treatment standards for the constituents to be regulated in K060 waste. The document explains how EPA determines BDAT, selects constituents for regulation, and calculates treatment standards. Section 2 presents waste-specific information–the number and location of facilities affected by the land-disposal restrictions, the waste-generating process, and waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which the proposed treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. The treatment standards are determined in Section 7.

31485 (PB–90-166190/XAB) **Proposed best demonstrated available technology (BDAT) background document for K061 (addendum). Volume 8.** Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 40p. (EPA–530/SW-90/011H). Available from NTIS, PC A03/MF A01.

See also Volume 7, PB–90-166182 and Volume 9, PB–90-166208. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the technical support and rationale for the development of treatment standards for K061 waste waters. The document is issued as an addendum to the August 1988 background document for K061, which accompanied the rulemaking for nonwaste water forms of K061. The Agency is proposing to regulate the same four BDAT list metal constituents that are regulated in K061 nonwaste waters.

31486 (PB–90-166216/XAB) **Treatment standards for K069 nonwaste waters in the Calcium Sulfate Subcategory and wastewater forms of K069. Volume 10.** Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. 8 Nov 1989. 30p. (EPA–530/SW-90/011J). Available from NTIS, PC A03/MF A01.

See also Volume 9, PB–90-166208 and Volume 11, PB–90-166224; Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This memorandum presents the technical support and rationale for the development of treatment standards for K069 nonwaste-waters in the Calcium Sulfate Subcategory and waste-water forms of K069.

31487 (PB–90-166224/XAB) **Treatment standards for nonwaste-water and waste-water forms of K100.** Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. 8 Nov 1989. 29p. (EPA–530/SW-90/011K). Available from NTIS, PC A03/MF A01.

See also Volume 10, PB–90-166216 and Volume 12, PB–90-166232. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This memorandum presents the technical support and rationale for the development of treatment standards for nonwaste-water and wastewater forms of K100. Waste code K100 is listed as waste-leaching solution from acid leaching of emission-control dust/sludge from secondary lead smelting.

31488 (PB–90-166232/XAB) **Proposed best demonstrated available technology (BDAT) background document for F006 (addendum). Volume 12.** Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 61p. (EPA–530/SW-90/011L). Available from NTIS, PC A04/MF A01.

See also Volume 11, PB–90-166224, Volume 13, PB–90-166240 and PB–89-142467. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

The document provides the Agency's rationale and technical support for selecting constituents to be regulated in F006 wastewaters and for developing proposed treatments standards for those regulated constituents. The document is an addendum to the supporting Best Demonstrated Available Technology background documents for F006 nonwastewaters.

31489 (PB–90-166240/XAB) **Proposed addendum for F019 to the BDAT background document for cyanide wastes. Volume 13.** Rosengrant, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 53p. (EPA–530/SW-90/011M). Available from NTIS, PC A04/MF A01.

See also Volume 12, PB–90-166232, Volume 14, PB–90-166257 and PB–89-221485. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's rationale and technical support for selecting the constituents regulated in F019 nonwaste waters and wastewaters and for developing proposed Best Demonstrated Available Technology (BDAT) standards for those regulated constituents. The document is an addendum to the support BDAT background document for cyanide wastes (F006-F012), June 1989.

31490 (PB–90-166257/XAB) **Proposed best demonstrated available technology (BDAT) background document for K011, K013, and K014 (addendum). Volume 14.** Chatman-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 49p. (EPA–530/SW-90/011N). Available from NTIS, PC A03/MF A01.

See also Volume 13, PB–90-166240, Volume 15, PB–90-166265 and PB–89-139646. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This document presents the technical support and rationale for the development of treatment standards for K011/K013/K014 waste waters. Treatment standards for nonwaste water forms of K011/K013/K014 were promulgated in the 2nd 3rds Final Rulemaking on June 23, 1989. The document is an addendum to the June 1989 background document for K011/K013/K014 that accompanied the rulemaking for wastewater forms of K011/K013/K014. The Agency is proposing to regulate the same five BDAT list constituents that are regulated in K011/K013/K014 nonwaste waters. These standards are based on the treatment performance of wet air oxidation.

31491 (PB–90-166265/XAB) **Proposed best demonstrated available technology (BDAT) background document amendment for F002 (1, 1, 2-trichloroethane) and F005 (benzene, 2-ethoxyethanol, and 2-nitropropane). Volume 15.** Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 57p. (EPA–530/SW-90/011O). Available from NTIS, PC A04/MF A01.

See also Volume 14, PB–90-166257 and Volume 16, PB–90-166273. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the data and rationale for the development of treatment standards for 1,1,2-trichloroethane (F002), benzene (F005), 2-ethoxyethanol (F005), and 2-nitropropane (F005). The document is issued as an amendment to the November 1986 background document for F001-F005 spent solvents. The proposed treatment standards for 1,1,2-trichloroethane (F002), benzene (F005), 2-ethoxyethanol (F005), and 2-nitropropane (F005) are presented in the document. The technologies used as the basis for BDAT are presented in Section 3, and the treatment data used to develop specific performance levels are presented in Section 4. In Section 5 the BDAT is selected for each solvent. Section 6 contains calculation of treatment standards for each solvent.

31492 (PB–90-166273/XAB) **Proposed best demonstrated available technology (BDAT) background document for mercury wastes. Volume 16.** Rosengrant, L.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 155p. (EPA–530/SW-90/011P). Available from NTIS, PC A08/MF A01.

See also Volume 15, PB–90-166265 and Volume 17, PB–90-166281. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the Agency's rationale and technical support for developing regulatory treatment standards for mercury-containing wastes. Section 2 describes the industries affected by regulation of these wastes, explains the processes generating these wastes, and presents available waste-characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 contains performance data for the demonstrated technologies, and Section 5 analyzes these performance data to determine BDAT for each waste. Section 6 presents the rationale for selection of regulated constituents, and Section 7 presents the proposed BDAT treatment standards for the regulated constituents selected for each waste.

31493 (PB–90-166281/XAB) **Proposed best demonstrated available technology (BDAT) background document for P and U thallium wastes. Volume 17.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 30p. (EPA–530/SW-90/011Q). Available from NTIS, PC A03/MF A01.

See also Volume 16, PB–90-166273 and Volume 18, PB–90-166299. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the Agency's technical support and rationale for developing regulatory standards for thallium-containing wastes. Section 2 presents the number and location of facilities affected by the land disposal restrictions, the waste-generating process, and waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. Proposed treatment standards are determined in Section 7.

31494 (PB–90-166299/XAB) **Proposed best demonstrated available technology (BDAT) background document for P119 and P120. Volume 18.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 31p. (EPA–530/SW-90/011R). Available from NTIS, PC A03/MF A01.

See also Volume 17, PB–90-166281 and Volume 19, PB–90-166307. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the Agency's technical support and rationale for developing regulatory standards for vanadium-containing wastes. Sections 2 through 6 present waste-specific information for P119 and P120 wastes. Section 2 presents the number and location of facilities affected by the land-disposal restrictions, the waste-generating processes, and waste-characterization data. Section 3 discusses the technologies used to treat the wastes (or similar wastes), and Section 4 presents available performance data, including data on which treatment standards are based. Section 5 explains EPA's determination of BDAT. Proposed treatment standards for vanadium wastes are determined in Section 6.

31495 (PB–90-166307/XAB) **Proposed best demonstrated available technology (BDAT) background document for barium wastes D005 and P013. Volume 19.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 34p. (EPA–530/SW-90/011S). Available from NTIS, PC A03/MF A01.

See also Volume 18, PB–90-166299 and Volume 20, PB–90-166315. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This document presents the Agency's technical support and rationale for developing proposed regulatory standards for barium-containing wastes. Sections 2 through 6 present waste-specific information for the D005 wastes. Section 2 describes the industries affected by the regulation of these wastes, explains the processes generating these wastes, and presents available waste-characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 presents available performance data for the demonstrated technologies; Section 5 contains analyses of the performance data to determine BDAT; and Section 6 contains the determination of the proposed treatment standards for the regulated constituent (barium). Section 7 discusses associated P-code barium-containing wastes (P013 - barium cyanide) and details the development of the proposed treatment standard for these wastes.

31496 (PB–90-166315/XAB) **Proposed best demonstrated available technology (BDAT) background document for D006 cadmium wastes. Volume 20.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 45p. (EPA–530/SW-90/011T). Available from NTIS, PC A03/MF A01.

See also Volume 19, PB–90-166307 and Volume 21, PB–90-166323. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the Agency's rationale and technical support for developing regulatory standards for cadmium-containing wastes. Sections 2 through 6 present waste-specific information for the D006 wastes. Section 2 presents the number and location of facilities affected by the land disposal restrictions, the waste-generating process, and waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which treatment standards are based. Section 5 explains EPA's determination of BDAT. Proposed treatment standards for cadmium wastes are determined in Section 6.

31497 (PB–90-166323/XAB) **Proposed best demonstrated available technology (BDAT) background document for chromium wastes D007 and U032. Volume 21.** Rosengrant, L.;

Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 57p. (EPA–530/SW-90/011U). Available from NTIS, PC A04/MF A01.

See also Volume 20, PB–90-166315 and Volume 22, PB–90-166331. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for the development of proposed treatment standards for the constituents to be regulated for the chromium-containing wastes. Section 2 describes the industries affected by regulation of these wastes, explains the processes generating these wastes, and presents available waste-characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 contains performance data for the demonstrated technologies, Section 5 contains analyses of these performance data to determine BDAT for each waste, and Section 6 contains the determination of the proposed BDAT treatment standards for the regulated constituents (chromium). Section 7 discusses associated chromium-containing U-code wastes (U032 - calcium chromate) and details the development of the proposed treatment standards for these wastes.

31498 (PB–90-166331/XAB) **Proposed best demonstrated available technology (BDAT) background document for D008 and P and U lead wastes. Volume 22.** Rosengrant, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 67p. (EPA–530/SW-90/011V). Available from NTIS, PC A04/MF A01.

See also Volume 21, PB–90-166323 and Volume 23, PB–90-166349. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for the development of proposed treatment standards for the constituents to be regulated for lead-containing wastes. Section 2 describes the industries affected by regulation of these wastes, explains the processes generating these wastes, and presents available waste-characterization data. Section 3 specifies the applicable and demonstrated treatment technologies for these wastes. Section 4 contains performance data for the demonstrated technologies. Section 5 analyzes these performance data to determine BDAT for each waste, and Section 6 presents the promulgated BDAT treatment standards for the regulated constituents. Section 7 discusses associated lead-containing P- and U-code wastes and details the development of the proposed treatment standards for these wastes.

31499 (PB–90-166349/XAB) **Proposed best demonstrated available technology (BDAT) background document for D011, P099 and P104. Volume 23.** Rosengrant, L.; Chatmon-McEaddy, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 35p. (EPA–530/SW-90/011W). Available from NTIS, PC A03/MF A01.

See also Volume 22, PB–90-166331 and Volume 24, PB–90-166356. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document presents the Agency's technical support and rationale for developing regulatory standards for these wastes. Section 2 identifies the number and location of facilities affected by the land-disposal restrictions for D011 wastes, discusses processes generating these wastes, and presents all available waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which treatment standards are based. Section 5 explains EPA's determination of BDAT. Proposed treatment standards are determined in Section 6. Section 7 discusses associated silver-containing P-code wastes and details the development of treatment standards for these wastes.

31500 (PB–90-166356/XAB) **Proposed best demonstrated available technology (BDAT) background document for halogenated aliphatic U-wastes. Volume 24.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 150p. (EPA–530/SW-90/011X). Available from NTIS, PC A07/MF A01.

See also Volume 23, PB–90-166349 and Volume 25, PB–90-166364. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for selecting and developing the proposed treatment standards for halogenated aliphatic U wastes. Section 2 presents waste-specific information; Section 3 discusses the applicable and demonstrated technologies used to treat the waste; Section 4 summarizes the available performance data; Section 5 explains EPA's determination of BDAT; while Section 6 discusses the calculation of proposed BDAT treatment standards.

31501 (PB–90-166364/XAB) **Proposed best demonstrated available technology (BDAT) background document for polynuclear aromatic U-wastes. Volume 25.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 229p. (EPA–530/SW-90/011Y). Available from NTIS, PC A11/MF A02.

See also Volume 24, PB–90-166356 and Volume 26, PB–90-166372. Also available in set of 26 reports PC E99/MF E99, PB–90-166117.

This background document provides the Agency's technical support and rationale for selecting and developing the proposed treatment standards for polynuclear aromatic U wastes. Section 2 presents waste-specific information; Section 3 discusses the applicable and demonstrated technologies used to treat the waste (or similar wastes); Section 4 summarizes the available performance data, including data on which the treatment standards are based; Section 5 explains EPA's determination of BDAT, while Section 6 discusses the calculation of the proposed BDAT treatment standards.

31502 (PB–90-166380/XAB) **Proposed best demonstrated available technology (BDAT) (19 Volumes).** Rosengrant, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Aug 1989. 1912p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-166398 through PB–90-166588.

A separate abstract is included for each volume of this set.

31503 (PB–90-166398/XAB) **Proposed best demonstrated available technology (BDAT) background document for inorganic pigment wastes. Volume 1.** Rosengrant, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Aug 1989. 52p. (EPA–530/SW-90/012A). Available from NTIS, PC A04/MF A01.

See also Volume 2, PB–90-166406 and PB–89-142269. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document presents the Agency's technical support and rationale for developing regulatory standards for K002, K003, K004, K005, K006, K007, and K008 wastes. Section 2 presents the number and location of facilities affected by the land-disposal restrictions, the waste-generating process, and waste-characterization data. Section 3 discusses the technologies used to treat the waste (or similar wastes), and Section 4 presents available performance data, including data on which treatment standards are based. Section 5 explains EPA's determination of BDAT, while Section 6 discusses the selection of constituents to be regulated. Proposed treatment standards are determined in Section 7.

31504 (PB–90-166406/XAB) **Proposed treatment technology background document. Volume 2.** Berlow, J.R.; Rosengrant, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 235p. (EPA–530/SW-90/012B). Available from NTIS, PC A11/MF A02.

See also Volume 1, PB–90-166398 and Volume 3, PB–90-166414. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This document provides a discussion of the purposes and contents of each of the various elements presented in each technology section. The document explains what information is provided in each technology subsection, how the Agency intends to use the information as part of its BDAT program, and how the Agency intends to modify the treatment-technology discussions as more treatment data and information become available.

31505 (PB–90-166414/XAB) **Proposed best demonstrated available technology (BDAT) background document for wastes from the production of chlorinated aliphatics F205. Volume 3.** Rosengrant, L.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 28p. (EPA–530/SW-90/012C). Available from NTIS, PC A03/MF A01.

See also Volume 2, PB–90-166406, Volume 4, PB–90-166422 and PB–89-221501. Also available in set of 5 reports PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in F025 and for developing treatment standards for these constituents; presents waste-specific information (the industry affected and waste characterization); discusses the applicable and demonstrated technologies used to treat the waste; summarizes the available performance data, including data on which the treatment standards are based; explains EPA's determination of BDAT; and discusses the calculation of the proposed BDAT treatment standards.

31506 (PB–90-166422/XAB) **Proposed best demonstrated and available technology (BDAT) background document for wastes from the production of epichlorohydrin K017. Volume 4.** Berlow, J.R.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 73p. (EPA–530/SW-90/012D). Available from NTIS, PC A04/MF A01.

See also Volume 3, PB–90-166414 and Volume 5, PB–90-166430. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K017 and for developing treatment standards for these constituents. The document also provides waste-characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K017 that is more difficult to treat than the wastes that were analyzed in developing the treatment standards for K017.

31507 (PB–90-166430/XAB) **Proposed amendment to best demonstrated available technology (BDAT) background document for wastes from the production of 1, 1, 1-trichloroethane K028, K029, K095, and K096. Volume 5.** Berlow, J.R.; Eby, E. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 68p. (EPA–530/SW-90/012E). Available from NTIS, PC A04/MF A01.

See also Volume 4, PB–90-166422, Volume 6, PB–90-166448 and PB–89-221519. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This amendment document describes the technologies used to treat K028 nonwastewater metals and K029, K095, and K096 waste waters (or similar wastes, if any) and presents the treatment performance data on which the treatment standards for these wastes are based. The document also explains how EPA determined BDAT, selected constituents for regulation, and calculated proposed treatment standards for K028 nonwaste water metals and K029, K095, and K096 wastewaters.

31508 (PB–90-166448/XAB) **Proposed best demonstrated available technology (BDAT) background document for waste waters containing BDAT-List constituents. Volume 6.** Berlow, J.R.; Kinch, R. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Oct 1989. 364p. (EPA–530/SW-90/012F). Available from NTIS, PC A16/MF A02.

See also Volume 5, PB–90-166430 and Volume 7, PB–90-166455. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document presents a technical database of waste-water treatment performance data for BDAT List constituents. In addition, the document provides the Agency's retionale and technical support for selecting specific treatment performance data for use in calculating a BDAT waste-water treatment standard for each BDAT List constituent. The Agency's legal authority and promulgated methodology for establishing treatment standards is summarized in EPA's methodology for developing BDAT treatment standards. The background document presents the sources of treatment performance data used for evaluation of BDAT, the criteria used in screening data from these sources, and the criteria used by the BDAT program (BDAT Methodology) for screening data for use in determining BDAT. The document presents waste-water treatment performance data available for each BDAT List constituent, a discussion of which data were used as BDAT, and presents the calculation of BDAT treatment standards.

31509 (PB–90-166455/XAB) **Proposed best demonstrated available technology (BDAT) background document for miscellaneous halogenated organic wastes, wastes of a pharmaceutical nature, brominated organic wastes, organo-sulfur compound wastes, and organo-nitrogen compound wastes. Volume 7.** Berlow, J.R.; Jones, L. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 220p. (EPA–530/SW-90/012G). Available from NTIS, PC A10/MF A02.

See also Volume 6, PB–90-166448 and Volume 8, PB–90-166463. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This document provides the Agency's rationale and technical support for developing treatment standards for halogen organic wastes and pharmaceutical wastes. Section 2.0 of the background document presents the approximate number and geographic distribution of facilities that may be affected by the land-disposal restrictions, the processes generating these wastes, and available waste characterization data. Section 2.0 also includes EPA's rationale for combining certain waste codes into the five treatability groups. EPA's rationale for identifying BDAT for wastes included in the document is presented in Section 3.0. Section 4.0 contains treatment performance data that the Agency has used to determine BDAT and proposed treatment standards for the wastes included in the document. EPA's rationale for selecting constituents for proposed regulation by means of numerical treatment standards is presented in Section 5.0. Section 6.0 includes the determination of proposed treatment standards for the miscellaneous compounds.

31510 (PB–90-166463/XAB) **Proposed best demonstrated available technology (BDAT) background document for oxygenated hydrocarbon and heterocyclic U and P wastes. Volume 8. Draft report.** Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 89p. (EPA–530/SW-90/012H). Available from NTIS, PC A05/MF A01.

See also Volume 7, PB–90-166455 and Volume 9, PB–90-166471. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting constituents being proposed for regulation and for developing treatment standards for these wastes. The document also provides waste-characterization data that serve as a basis for determining whether a variance from treatment standards may be warranted for a particular oxygenated hydrocarbon and heterocyclic waste that is more difficult to treat than the wastes that were tested and from which treatment performance data were used to develop the treatment standards for the wastes included in the background document.

31511 (PB–90-166471/XAB) **Proposed amendment to the final best demonstrated available technology (BDAT) background document for K022. Volume 9.** Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 61p. (EPA–530/SW-90/012I). Available from NTIS, PC A04/MF A01.

See also Volume 8, PB–90-166463, Volume 10, PB–90-166489 and PB–89-142517. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This document presents treatment performance data that were transferred to K022 and used to develop treatment standards for waste-water forms of K022; EPA's rationale and technical support for selecting the constituents proposed for regulation in waste-water forms of K022; and EPA's approach to and technical support for developing treatment standards for these constituents.

31512 (PB–90-166489/XAB) **Proposed best demonstrated available technology (BDAT) background document for distillation bottoms from the production of aniline K083. Volume 10.**

Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 79p. (EPA–530/SW-90/012J). Available from NTIS, PC A05/MF A01.

See also Volume 9, PB–90-166471 and Volume 11, PB–90-166497. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K083 and for developing treatment standards for these constituents. The document also provides waste-characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K083 that is more difficult to treat than the wastes that were analyzed in developing treatment standards for K083.

31513 (PB–90-166497/XAB) **Proposed best demonstrated available technology (BDAT) background document for distillation bottoms from the production of nitrobenzene by the nitration of benzene K025. Volume 11.** Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 71p. (EPA–530/SW-90/012K). Available from NTIS, PC A04/MF A01.

See also Volume 10, PB–90-166489 and Volume 12, PB–90-166505. Also available in set 19 reports PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting the constituents for proposed regulation in K025 and for developing treatment standards for these constituents. The document also provides waste-characterization data that serve as a basis for determining whether a variance from a treatment standard may be warranted for a particular type of K025 that is more difficult to treat than the wastes that were analyzed in developing treatment standards for K025.

31514 (PB–90-166505/XAB) **Proposed best demonstrated available technology (BDAT) background document for stripping still tails from the production of methyl ethyl pyridine K026. Volume 12.** Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 50p. (EPA–530/SW-90/012L). Available from NTIS, PC A03/MF A01.

See also Volume 11, PB–90-166497 and Volume 13, PB–90-166513. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document presents waste-specific information on the number and locations of facilities that may be affected by the land disposal restrictions for K026, the processes generating this waste, the waste-characterization data, the technologies used to treat the waste (or similar wastes, if any), and the treatment performance data on which the proposed treatment standards are based. The document also explains how EPA determines BDAT, selects constituents to be regulated, and calculates treatment standards.

31515 (PB–90-166513/XAB) **Proposed best demonstrated available technology (BDAT) background document for wastewater treatment sludges generated in the production of creosote K035. Volume 13.** Berlow, J.R.; Labiosa, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 74p. (EPA–530/SW-90/012M). Available from NTIS, PC A04/MF A01.

See also Volume 12, PB–90-166505 and Volume 14, PB–90-166521. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This background document presents waste-specific information on the number and locations of facilities that may be affected by the land-disposal restrictions for K035, the processes generating this waste, the waste-characterization data, the technologies used to treat the waste (or similar wastes, if any), and the treatment performance data on which the proposed treatment standards are based. The document also explains how EPA determines BDAT, selects constituents to be regulated, and calculates treatment standards.

31516 (PB–90-166539/XAB) **Proposed amendment to best demonstrated available technology (BDAT) background for K037. Volume 15. Draft report.** Berlow, J.R.; Cunningham, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 25p. (EPA–530/SW-90/012O). Available from NTIS, PC A03/MF A01.

See also Volume 14, PB–90-166521, Volume 16, PB–90-166547 and PB89-142434. Also available in set of 19 reports, PC E99/MF E99, PB–90-166380.

This amendment presents a discussion of biological treatment as an applicable and demonstrated technology for reducing regulated constituents in organophosphorus waste-water streams, performance data supporting biological treatment as an effective technology for treating organophosphorus wastewater streams, rationale for transferring biological-treatment performance data to wastewater forms of K037, and calculation of new numerical standards. Specifically, Section 2 of the document supplements Section 3 of the Final BDAT Background Document for K037 by introducing biological treatment as an applicable and demonstrated technology for treating waste-water forms of K037. Section 3 of the document amends Section 4 of the Final BDAT Background Document for K037 by adding performance data for biological treatment of parathion and toluene. Section 4 amends Section 5.2 by identifying biological treatment as BDAT for K037 waste-waters. Finally, Section 5 amends Section 7 by presenting revised numerical treatment standards for disulfoton and toluene in K037 waste-waters.

31517 (PB–90-166547/XAB) **Proposed best demonstrated available technology (BDAT) background document for halogenated pesticide and chlorobenzene, halogenated phenolic, and phenolic wastes. Volume 16.** Berlow, J.R.; Cunningham, M. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 168p. (EPA–530/SW-90/012P). Available from NTIS, PC A08/MF A01.

See also Volume, PB–90-166539 and Volume 17, PB–90-166554. Also available in set of 19 reports, PC E99/MF E99, PB–90-166380.

This background document provides the Agency's rationale and technical support for selecting constituents being proposed for regulation and for developing treatment standards for these wastes. The document also provides waste-characterization data that serve as a basis for determining whether a variance from treatment standards may be warranted for a particular halogenated pesticide, and chlorobenzene, halogenated phenolic waste that is more difficult to treat than the wastes that were tested and from which treatment performance data were used to develop the treatment standards for the wastes included in the background document.

31518 (PB–90-166554/XAB) **Proposed amendment to the final best demonstrated available technology (BDAT) background document for wastes from the production of chlorinated aliphatic hydrocarbons (F024). Volume 17.** Berlow, J.R.; Vorbach, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Nov 1989. 41p. (EPA–530/SW-90/012Q). Available from NTIS, PC A03/MF A01.

See also Volume 16, PB–90-166547, Volume 18, PB–90-166562, and PB89-221501. Also available in set of 19 reports PC E99/MF E99, PB–90-166380.

This addendum to the Best Demonstrated Available Technology Background Document for F024 presents F024 incinerator-ash stabilization data; EPA's rationale and technical support for selecting the metal constituents being proposed for regulation in nonwaste water forms of F024; and EPA's approach to and technical support for developing treatment standards for these constituents.

31519 (PB–90-167511/XAB) **Final-generic environmental impact statement for waste-water management in rural lake areas. Final report.** Illinois Environmental Protection Agency, Springfield, IL (USA). Jan 1983. 330p. Available from NTIS, PC A15/MF A02.

The environmental impact statement examines the environmental, economic, social costs within Region V of rural-lake waste-water planning. Seven projects are used to demonstrate managing on-site and small-scale alternatives to conventional waste-water treatment. This also can be used as a manual for planning and constructing rural lake projects.

31520 (PB–90-173774/XAB) **Improvement of lake water quality by paying farmers to abate nonpoint source pollution. Research report.** Lupi, F.; Farnsworth, R.L.; Braden, J.B. Illinois

Univ., Urbana, IL (USA). Water Resources Center. Dec 1988. 106p. (UILU-WRC–88-210). Available from NTIS, PC A06/MF A01.

To mitigate damages caused by agricultural runoff, private lake owners' associations are paying for inlake and instream pollution abatement measures and on land-conservation practices. This phenomenon supports the notion that individuals who benefit from improved water quality should be willing to pay part of the abatement costs. The research suggests that on land-conservation measures can substantially reduce sediment delivery at low cost. The Sediment Economics (SEDEC) model was modified and then used to select and to site management systems that achieved stated sediment goals at least cost. Other resource policies such as T value, no-till, and contouring were compared with the least-cost frontier and shown to be more costly. The noncropland areas substantially reduced sediment delivery to water channels and lowered abatement costs. Further research is needed for long-range watershed-planning models such as SEDEC.

31521 (PB–90-173915/XAB) **Benthic macrofauna and habitat monitoring on the Continental Shelf of the northeastern United States. I. Biomass. Technical report.** Steimle, F.W. National Marine Fisheries Service, Highlands, NJ (USA). Sandy Hook Lab. Feb 1990. 37p. (NOAA-TM-NMFS–86). Available from NTIS, PC A03/MF A01.

Information on long-term temporal variability of and trends in benthic community-structure variables, such as biomass, is needed to estimate the range of normal variability in comparison with the effects of environmental change or disturbance. Fishery resource distribution and population growth will be influenced by such variability. The study examines benthic macrofaunal biomass and related data collected annually between 1978 and 1985 at 27 sites on the continental shelf of the northwestern Atlantic, from North Carolina to the southern Gulf of Maine. The study was expanded at several sites with data from other studies collected at the same sites prior to 1978. Results indicate that although there was interannual and seasonal variability, as expected, biomass levels over the study period showed few clear trends.

31522 (PB–90-174863/XAB) **Effects of highway runoff on the quality of water and bed sediments of two wetlands in central Florida. Report of investigations.** Schiffer, D.M. Geological Survey, Tallahassee, FL (USA). Water Resources Div. 1989. 72p. (USGS/WRI–88-4200). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

Results of a study of the effects of highway runoff on the chemical quality of water and bed sediments of a cypress wetland and a freshwater marsh in central Florida indicate that detention of the runoff prior to release into the wetland reduces concentrations of automobile-related chemicals in the water and bed sediments in the wetland. Detention of highway runoff for the cypress wetland occurs in a 68- by 139-foot detention pond, and in a 12- by 25-foot trash retainer for the freshwater marsh. Results from the study indicate that detention structures, larger than the trash retainer at the freshwater marsh, may cause sufficient sorption and settling of substances contained in highway runoff.

31523 (PB–90-174921/XAB) **Anhydrite deposits of the United States and characteristics of anhydrite important for storage of radioactive wastes. Bulletin.** Dean, W.E.; Johnson, K.S. Oklahoma Geological Survey, Norman, OK (USA). 1989. 143p. (USGS-BULL–1794). Available from NTIS, PC A07/MF A01.

Also available from Supt. of Docs. Library of Congress catalog card No. 87-600220.

The investigation presents an inventory of major anhydrite deposits in the United States and describes their geologic, structural, hydrologic, physical, and geochemical characteristics that are important for evaluating anhydrite as a potential medium for disposal of high-level radioactive wastes. Although the literature on all major deposits of anhydrite has been examined and summarized, the emphasis of the report is on 20 deposits that contain individual beds of anhydrite more than 30 m (meters) thick and between 300 and 1,500 m beneath the Earth's surface. The preliminary survey of existing data constitutes the first step in assessing the suitability of anhydrite as a medium for storage of radioactive wastes.

31524 (PB–90-174970/XAB) **Techniques of water-resources investigations of the United States Geological Survey: Chapter A1. Methods for determination of inorganic substances in water and fluvial sediments. Book 5. Laboratory analysis. (Third edition).** Geological Survey, Reston, VA (USA). Water Resources Div. 1989. 475p. Available from NTIS, PC A20/MF A03.

Also available from Supt. of Docs.

The laboratory manual contains methods used by the U.S. Geological Survey to analyze samples of water, suspended sediments, and bottom material for their content of inorganic constituents. Included are methods for determining the concentration of dissolved constituents in water, the total recoverable and total of constituents in water-suspended sediment samples, and the recoverable and total concentrations of constituents in samples of bottom material. A brief discussion of the principles of the analytical techniques involved and their particular application to water and sediment analysis is presented. The analytical methods of these techniques are arranged alphabetically by constituent. For each method, the general topics covered are the application, the principle of the method, the interferences, the apparatus and reagents required, a detailed description of the analytical procedure, reporting results, units and significant figures, and analytical precision data, when available.

31525 (PB–90-177833/XAB) **Superfund Record of Decision (EPA Region 9): Kopper's (Oroville Plant), CA. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 13 Sep 1989. 74p. (EPA/ROD/R–09-89/037). Available from NTIS, PC A04/MF A01.

The Koppers (Oroville Plant) site is a 200-acre operating wood treating plant in Butte County, California, just south of Oroville. Although there is a history of wood-treating operations at the site, wood-treating operations were greatly expanded in 1955 when Koppers Company, Inc. became the owner and operator. Chemical preservatives including pentachlophenol (PCP), creosote, and chlorinated copper arsenate solution have been used in the wood treating processes. Waste-water discharge and other site activities have resulted in contamination of unlined ponds, soil, and debris. Pursuant to a State order, Koppers conducted cleanup activities from 1973-74, including ground-water pumping and discharge to spray fields and offsite disposal of contaminated debris, and process changes, including construction of a waste-water treatment plant. In 1986 Koppers provided an alternate water supply for domestic uses to affected residents. The selected remedial action for this site includes a soil component and a ground-water component.

31526 (PB–90-177841/XAB) **Superfund Record of Decision (EPA Region 5): Windom Dump, Windom, MN. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 53p. (EPA/ROD/R–05-89/116). Available from NTIS, PC A04/MF A01.

The 11-acre Windom Dump site is a former municipal landfill in Windom, Cottonwood County, Minnesota. Land use in the vicinity of the site includes residential areas and commercial, industrial, and agricultural operations. City water-supply wells northwest of the site lie downgradient of the landfill. Landfilling operations began in the 1930s and continued until 1974. During this period, paint sludges from a large manufacturing operation were disposed of along with municipal refuse resulting in low levels of toxic substances contaminating an underlying aquifer, which is used as a water supply. The primary contaminants of concern affecting the ground water are VOCs including benzene, PCE, and TCE; metals including arsenic; and other inorganics. The selected remedial action for this site includes grading and capping the fill area with a 2-foot-clay cap overlain by one foot of granular material, topsoil, and new vegetation; modifying the existing municipal water plant by installing additional aeration nozzles and structure venting; and ground water monitoring.

31527 (PB–90-177866/XAB) **Superfund Record of Decision (EPA Region 2): Vineland State School, New Jersey (First remedial action). September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1989. 107p. (EPA ROD/R–02-89/092). Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

The 195-acre Vineland State School site is in the northern part of the city of Vineland, Cumberland County, New Jersey. The site overlies three aquifers which serve as major sources of drinking water for the county. There were numerous allegations of improper waste disposal at five separate onsite subsites. Subsite 1, a former landfill which has since been used to covered and vegetated, reportedly had been used to dump mercury- and arsenic-contaminated pesticides. At subsite 2, PCB-contaminated fluid spilled and spread over a 1-acre area. The State remediated subsite 2 in 1988, which included demolishing and disposing of approximately 3,900 tons of PCB-contaminated soil and concrete pads offsite. Subsite 3 was a garbage dump for 10 years before being backfilled and used as a baseball field. Subsites 4 and 5 were pits where transformer oils and chemicals were dumped in the mid 1950s. Investigation results of the subsites excluding subsite 2, which was cleaned up in 1988, revealed only low levels of contamination.

31528 (PB–90-178013/XAB) **Superfund Record of Decision (EPA Region 2): SMS Instruments, Deer Park, Suffolk County, New York (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 102p. (EPA/ROD/R–02-89/083). Available from NTIS, PC A06/MF A01.

The 1.5-acre SMS Instruments site is in a light industrial and residential area of Deer Park, Suffolk County, New York. Since 1967 the site has been operated as an industrial facility which overhauls military aircraft components. In 1980 the site owner removed 800 gallons of VOC- and metal-contaminated waste water from the pool, and subsequently filled it with sand and sealed all drain pipes. In 1981 the county required the site owner to leak test a 6,000-gallon underground storage tank (UST) used to store jet fuel. Because tests indicated leakage, the tank was emptied and, in 1988, was excavated and removed. This Record of Decision represents the first of two operable units at the site and addresses ground water and soil contamination. The selected remedial action for the site includes treating approximately 1,250 cubic yards of soil using in situ steam stripping or air stripping depending on the results of a planned treatability study.

31529 (PB–90-178021/XAB) **Superfund Record of Decision (EPA Region 5): New Brighton/Arden Hills, Minnesota (Fourth remedial action), (Amendment), August 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 11 Aug 1989. 13p. (EPA/ROD/R–05-89/117). Available from NTIS, PC A03/MF A01.

The New Brighton/Arden Hills site is an area of organic solvent contamination in ground water northwest of Minneapolis, Minnesota. The site includes the cities of New Brighton, Arden Hills, and St. Anthony as well as the Twin Cities Army Ammunition plant. The Record of Decision (ROD) amends a June 1986 ROD calling for the installation of a new well to provide part of the drinking water supply to New Brighton. EPA has concluded that a new well is no longer necessary to protect human health in New Brighton. Originally it was anticipated that low contamination levels in Well No. 7 (one of nine municipal wells) could not be assured and that a replacement well in a deeper aquifer was needed to provide an alternate supply of water. However, further data from Well No. 7 indicate contamination is not increasing. A large water supply will be provided by the U.S. Army to New Brighton as part of a litigation settlement, and a system has been installed by the U.S. Army to prevent further contamination from the suspected sources.

31530 (PB–90-178047/XAB) **Superfund Record of Decision (EPA Region 3): Henderson Road NPL Site, Upper Merion Township, Pennsylvania (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 128p. (EPA/ROD/R–03-89/081). Available from NTIS, PC A07/MF A01.

The Henderson Road site is a 7.6-acre site in Upper Merion Township, Pennsylvania. O'Hara Sanitation Company, Inc. has used the site for waste storage, waste recycling, vehicle maintenance, and parking and office facilities since 1974. The site is bounded by the Pennsylvania Turnpike, the Conrail property including train tracks, Henderson Road, and Frog Run. In 1974 William J. O'Hara, Inc. began landfilling trash and construction debris on central and eastern portions of the site until 1984. The first operable unit for the site, as described in a June 1988 Record of Decision, included pumping and treatment, using air strippers, of contaminated ground water. This will be accompanied by additional characterization of the injection well, excavation of oil-pit sediment if found, and removal of significant waste within the well.

31531 (PB–90-178104/XAB) **Superfund Record of Decision (EPA Region 2): Picatinny Arsenal, NJ. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Sep 1989. 85p. (EPA/ROD/R–02-89/093). Available from NTIS, PC A05/MF A01.

The Picatinny Arsenal is a munitions and weapons research and development installation covering 6,491 acres and containing 1,500 buildings in Morris County, near the city of Dover, New Jersey. Ground water contamination above State and Federal action levels was detected in the vicinity of Building 24, where past waste-water treatment practices resulted in the infiltration of metal-plating waste constituents (i.e., VOCs and heavy metals) into the ground water. Two unlined lagoons alongside Building 24, thought to be a source of contamination, were eliminated during a 1981 action during which the unlined lagoons were demolished, contaminated soil removed, and two concrete lagoons installed. Two additional potential sources of contamination are a dry well at Building 24 and a former drum storage area at Building 31, directly across the street from Building 24. The interim ground-water cleanup remedy is designed to prevent deterioration to Green Pond Brook, a major drainage artery onsite, while the Arsenal a a whole is evaluated. The primary contaminants of concern affecting the ground water are VOCs including TCE and metals.

31532 (PB–90-178112/XAB) **Superfund Record of Decision (EPA Region 3): Havertown PCP Site, Haverford Township, Delaware County, Pennsylvania (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 58p. (EPA/ROD/R–03-89/076). Available from NTIS, PC A04/MF A01.

The Havertown PCP site is in Havertown, Delaware County, Pennsylvania, approximately 10 miles west of Philadelphia. This 12- to 15-acre site consists of a wood-treatment facility, an adjacent manufacturing facility, and Naylors Run Creek which drains the area. Contamination at the site is due to improper disposal of wastes generated from wood-preserving operations. From 1947 to 1963 PCP-contaminated oil was dumped into a well. In 1972 the State identified contaminated ground water discharging from a storm sewer into Naylors Run. In 1988 EPA installed a catch basin in Naylors Run to trap discharge from the storm-sewer pipe. This Record of Decision (ROD), addresses the remediation of surface water and the disposal of drummed and tanked wastes. A subsequent ROD will address the impact of contaminated soil on ground-water contamination at the site. The primary contaminants of concern affecting the surface water are VOCs including benzene, toluene and TCE; other organics including phenols, dioxins, PCP, and PAHs; metals including arsenic and chromium; and oils.

31533 (PB–90-178500/XAB) **Superfund Record of Decision (EPA Region 5): Kysor Industrial, Cadillac, Michigan (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 142p. (EPA/ROD/R–05-89/113). Available from NTIS, PC A07/MF A01.

The Kysor facility is a large truck parts manufacturing plant in the Cadillac industrial park in the city of Cadillac, Wexford County, Michigan. Approximately 40 industries operate in the 1-square-mile industrial park including Northernaire, another Superfund site. The Kysor facility commonly uses solvent cleaner and degreasers; past disposal practices included dumping barrels of spent solvent directly on the soil behind the plant. Kysor excavated approximately 700 cubic yards of soil in 1981 after contaminants were discovered in ground water samples. The selected remedial action for the site includes a two-stage ground water pumping and treatment system

using carbon adsorption for the removal of chromium and air stripping with vapor-phase carbon adsorption for the removal of VOCs.

31534 (PB–90-178534/XAB) **Superfund Record of Decision (EPA Region 7): Cherokee County/Galena, Kansas (Second remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 18 Sep 1989. 124p. (EPA/ROD/R–07-89/030). Available from NTIS, PC A06/MF A01.

See also PB–89-128375.

The Cherokee County site is a lead and zinc mining area in the southeastern corner of Kansas. The 25 square-mile Galena subsite is one of six subsites within the Cherokee County site and consists of large areas covered by mine wastes, water-filled subsidence craters, and open mine shafts. The approximately 3,500 Galena residents receive their water supply from two deep aquifer wells. EPA began investigations of the Galena subsite in 1985 and determined that the shallow ground-water aquifer and surface water were contaminated with elevated concentrations of metals. EPA Region VII responded by installing water-treatment units on several private wells. The primary contaminants of concern affecting the ground water and surface water are metals including cadmium, lead, and zinc. The selected remedial action for the site includes the removal, consolidation, and onsite placement in mine pits, shafts, and subsidences of surface mine wastes; diversion and channelization of surface streams with recontouring and vegetation of land surface; and investigation of deep aquifer well quality.

31535 (PB–90-178542/XAB) **Superfund Record of Decision (EPA Region 4): Carolawn, Fort Lawn, Chester County, South Carolina (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 167p. (EPA/ROD/R–04-89/051). Available from NTIS, PC A08/MF A01.

The Carolawn site is an approximately 60-acre, abandoned waste-storage and disposal facility in Fort Lawn, Chester County, South Carolina. Approximately 2,500 people receive their water supply from the Catawba River. Storage trailers and tanks and as many as 480 drums of solvents and liquid and solid wastes have been stored inside a 3-acre fenced portion of the property since 1970. An additional 660 drums and 11 storage tanks were located outside the fenced area to the north. Drums, waste, and contaminated soil were removed from the site by EPA in 1981, and all nearby residences were provided an alternative water source. The primary contaminants of concern affecting the ground water are VOCs including TCE, and metals including lead. The selected remedial action for the site includes ground water pumping and treatment using one or more of the following methods: air stripping, biodegradation, activated-carbon filtration, and metals removal.

31536 (PB–90-178559/XAB) **Superfund Record of Decision (EPA Region 2): BEC Trucking, Town of Vestal, Broome County, New York (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Sep 1989. 54p. (EPA/ROD/R–02-89/086). Available from NTIS, PC A04/MF A01.

The BEC Trucking site, also known as the Binghamton Equipment Company, is in the town of Vestal, Broome County, New York. The 3.5-acre site is an open lot which overlies a Class II aquifer. Land use neighboring the site is primarily commercial/industrial, but includes wetlands or marsh area to the west. The original owner, Haial Trucking, later to become BEC Trucking, filled some of the marshlands with various fill materials, including fly ash from a local power company. BEC Trucking, Haial Trucking's successor, operated a combination truck-body fabrication and truck maintenance facility. Paint thinners and enamel reducers used during operations, and waste hydraulic oil and waste motor oil reportedly generated during operations were stored in a drum-storage area. A 1982 State inspection identified approximately 50 drums, 20 of which contained waste engine or cutting oils, enamel reducers, paint thinners, and waste solvents. In 1988 extensive sampling of ground water, surface water, and soil revealed low-level contamination. The suspected source of onsite ground-water and surface-water contamination appears to be a leaking underground storage tank on a neighboring property. Remedial activities are currently being undertaken at the neighboring site to address any ground-water or surface-water contamination at the site resulting from the tank's leakage.

31537 (PB–90-178831/XAB) **Superfund Record of Decision (EPA Region 9): Sacramento Army Depot, CA. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 25p. (EPA/ROD/R–09-89/043). Available from NTIS, PC A03/MF A01.

The 485-acre Sacramento Army Depot (SAAD) site, 7 miles southeast of downtown Sacramento, California, is surrounded by land zoned as commercial and light industrial property. SAAD is an electronic maintenance and repair depot consisting of storage, maintenance, and office facilities. Present operations include shelter repair, electro-optics equipment repair, metal plating, and treatment of metal-plating wastes. From approximately 1947 to 1972 paint sludges, oil, grease wood, trash, solvents and other industrial wastes were burned and disposed of onsite in burn pits. SAAD has since removed most of the burned material from the burn pits. The burn pits were subsequently covered with soil and revegetated. Ground-water samples, collected by SAAD from 1981 to 1984, indicated that several chemical compounds were present at levels above drinking-water standards in two areas. The primary contaminants of concern affecting the ground water are VOCs including TCE and PCE.

31538 (PB–90-178849/XAB) **Superfund Record of Decision (EPA Region 2): Marathon Battery, Cold Spring, NY. (Third remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 62p. (EPA/ROD/R–02-89/097). Available from NTIS, PC A04/MF A01.

The Marathon Battery site is a former battery-manufacturing plant in Cold Spring, Putnam County, New York. The site is composed of three study areas: Area I, which consists of East Foundry Cove Marsh and Constitution Marsh; Area II, which encompasses the former plant, presently a book-storage warehouse, the surrounding grounds, and a vault with cadmium contaminated sediment dredged from East Foundry Cove; and Area III, which includes East Foundry Cove (48 acres), West Foundry Cove and the Hudson River in the vicinity of Cold Spring pier and a sewer outfall. Contamination in Area III emanates from plant waste water that was discharged via the city sewer system into the Hudson River at Cold Spring Pier or, in some instances, through a storm sewer into East Foundry Cove. A Record of Decision (ROD) was signed for Area I in September 1986 with cleanup activities to include dredging the East Foundry Cove Marsh. The second ROD for the site was signed in September 1988 and included decontamination of the battery plant and soil excavation in Area II. The 1989 ROD represents the third and final operable unit for the site and addresses sediment contamination in Area III. The primary contaminants of concern affecting sediment at the site are metals, including cadmium and nickel.

31539 (PB–90-178898/XAB) **Superfund Record of Decision (EPA Region 2): North Sea Municipal Landfill, Southampton, NY. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 102p. (EPA/ROD/R–02-89/085). Available from NTIS, PC A06/MF A01.

The 131-acre active landfill overlies two aquifers and neighbors private homes that obtain their drinking water from private domestic wells. Municipal solid waste, refuse, debris, and septic system waste from residential, industrial, and commercial sources have been disposed of at the site since 1963. From the early 1960s to 1985 Cell 1 received approximately 1.3 million cubic yards of municipal waste and septic sludges. Subsequent ground-water monitoring revealed a contaminated plume migrating from Cell 1 toward a nearby cove. Cell 1 was closed and partially capped in 1985, and a storm-water diversion system was also installed to collect storm water and recharge it. Cell 2, which was equipped with a leachate collection system and accepted approximately 80,000 tons of municipal waste annually, has been closed since October 1989. The first of two planned operable units addresses source control through remediation of Cell 1 and the former sludge lagoons. A subsequent Record of Decision will address ground- and

surface-water contamination. The primary contaminants of concern affecting the soil and sludge are VOCs, other organics including PAHs, metals including arsenic and lead, and other inorganics.

31540 (PB–90-178906/XAB) **Superfund Record of Decision (EPA Region 10): Commencement Bay Nearshore/Tideflats, WA. (Second remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1989. 251p. (EPA/ROD/R–10-89/020). Available from NTIS, PC A12/MF A02.

See also PB–89-225544.

The Commencement Bay Nearshore/Tideflats site is in Tacoma, Pierce County, Washington at the southern end of the main basin of Puget Sound. Site contamination is the result of a long history of industrial activity in the area. More than 281 active industrial facilities are in the area and approximately 34 of those are NPDES permitted dischargers. Releases of hazardous substances to the marine environment have resulted in contamination of bottom sediment in the waterways of the Tideflats Industrial Area, and along the shoreline in the Nearshore Area. The Record of Decision represents two of six operable units for the site and will address source control and marine sediment contamination in the Nearshore/Tideflats environment. Eight problem areas are being addressed independently by this remedy. The remaining operable units will address remedial response to releases of hazardous substances associated with the Tacoma tar pits and the ASARCO Tacoma smelter. The primary contaminants of concern affecting the sediment are organics including PCBs and PAHs; and metals including arsenic, mercury, lead, and zinc.

31541 (PB–90-861907/XAB) **Water pollution: Uptake of heavy metals by shellfish and marine plants. January 1974-December 1989 (a Bibliography from Oceanic Abstracts). Report for January 1974-December 1989.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 128p. Available from NTISPC N01/MF N01.

Supersedes PB–88-866272.

This bibliography contains citations concerning heavy-metal contamination of shellfish and marine plants. Toxicity levels and the long-term effects on the ecology of the marine environment are discussed. The growth rate of marine life as a function of metal concentration and the long-term effects on the food chain are also considered. (This updated bibliography contains 276 citations, 13 of which are new entries to the previous edition.)

31542 (PB–90-862590/XAB) **Polychlorinated biphenyls in the freshwater environment. January 1977-February 1990 (a Bibliography from the Selected Water Resources Abstracts data base). Report for January 1977-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 204p. Available from NTISPC N01/MF N01.

Supersedes PB–89-858088.

This bibliography contains citations concerning the occurrence and effects of polychlorinated biphenyls in the fresh-water environment. Topics include sources, distribution, and accumulation rates for specific regions, bioaccumulation, pollutant paths and introduction into the food chain, and results of long- and short-term monitoring of selected areas. Detection methods for PCB accumulation in fish and surficial sediments are also considered. (This updated bibliography contains 358 citations, 42 of which are new entries to the previous edition.)

31543 (PNL–7296) **Multimedia Environmental Pollutant Assessment System (MEPAS) sensitivity analysis of computer codes.** Doctor, P.G.; Miley, T.B.; Cowan, C.E. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 134p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90010005. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The Multimedia Environmental Pollutant Assessment System (MEPAS) is a computer-based methodology developed by the Pacific Northwest Laboratory (PNL) for the US Department of Energy (DOE) to estimate health impacts from the release of hazardous chemicals and radioactive materials. The health impacts are estimated from the environmental inventory and release or emission rate, constituent transport, constituent uptake and toxicity, and exposure route parameters. As part of MEPAS development and evaluation, PNL performed a formal parametric sensitivity analysis to determine the sensitivity of the model output to the input parameters, and to provide a systematic and objective method for determining the relative importance of the input parameters. The sensitivity analysis determined the sensitivity of the Hazard Potential Index (HPI) values to combinations of transport pathway and exposure routes important to evaluating environmental problems at DOE sites. Two combinations of transport pathways and exposure routes were evaluated. The sensitivity analysis focused on evaluating the effect of variation in user-specified parameters, such as constituent inventory, release and emission rates, and parameters describing the transport and exposure routes. The constituents used were strontium-90, yttrium-90, tritium, arsenic, mercury, polychlorinated biphenyls, toluene, and perchloroethylene. 28 refs., 3 figs., 46 tabs.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

Refer also to citation(s) 31348, 31593

5502 Biochemistry

Refer also to citation(s) 30870, 31638, 31639, 31710

31544 (DOE/ER–0446P) **Human genome: 1989–90 program report.** USDOE Office of Energy Research, Washington, DC (USA). Office of Health and Environmental Research. Mar 1990. 156p. Sponsored by U.S. DOE Energy Research. Order Number DE90010171. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This nation's Human Genome Project is the first broadly based organized endeavor in the biological sciences. The project of mapping and sequencing the genome has the momentum to make major advances in the knowledge and technologies that are needed to understand the complexities of human cellular processes in a manner never before possible These advances will impact biological principles as well as the practice of medicine, the growing biotechnology industry, and society. This document is a status report on the Human Genome Program and includes a brief background to this agency's initiative as well as an explanation of the program's projected focus over the next 15 years. Of special interest are the section on research highlights, the narratives on major Genome research efforts conducted at three of DOE's national laboratories, and the abstracts of work in progress. Figures and captions provided by investigators give additional detailed information. 22 figs.

31545 (DOE/ER–0452P) **Understanding our genetic inheritance: The US Human Genome Project, The first five years FY 1991–1995.** National Center for Human Genome Research, Bethesda, MD (USA); USDOE Office of Energy Research, Washington, DC (USA). Office of Health and Environmental Research. Apr 1990. 89p. Sponsored by U.S. DOE Energy Research. Order Number DE90008240. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Human Genome Initiative is a worldwide research effort with the goal of analyzing the structure of human DNA and determining the location of the estimated 100,000 human genes. In parallel with this effort, the DNA of a set of model organisms will be studied to provide the comparative information necessary for understanding the functioning of the human genome. The information generated by the human genome project is expected to be the source book for biomedical science in the 21st century and will by of immense benefit to the field of medicine. It will help us to understand and eventually treat many of the more than 4000 genetic diseases that affect mankind, as well as the many multifactorial diseases in which genetic predisposition plays an important role. A centrally coordinated project focused on specific objectives is believed to be

the most efficient and least expensive way of obtaining this information. The basic data produced will be collected in electronic databases that will make the information readily accessible on convenient form to all who need it. This report describes the plans for the U.S. human genome project and updates those originally prepared by the Office of Technology Assessment (OTA) and the National Research Council (NRC) in 1988. In the intervening two years, improvements in technology for almost every aspect of genomics research have taken place. As a result, more specific goals can now be set for the project.

31546 (DOE/ER/60587–2) **[Repair of DNA treated with γ-irradiation and chemical carcinogens]: Progress report.** Case Western Reserve Univ., Cleveland, OH (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60587. Order Number DE90010524. Available from NTIS, PC A02/MF A01; GPO Dep.

This report discusses progress made on the search for human transposon project. Topics include isolation of the Alu sequence, analysis of the Ecogpt (gpt) clones, enzyme assay, mRNA assay, sequencing of the gpt gene clones and use of an long terminal repeat as a signaling system for UV and X-ray damage. (KS)

31547 (PNL-SA–18016) **Workshop on high-field NMR and biological applications.** Pacific Northwest Lab., Richland, WA (USA). [1989]. 67p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. (CONF-8909305–: Workshop on high field NMR and biological applications, Richland, WA (USA), 8-9 Sep 1989). Order Number DE90010002. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Scientists at the Pacific Northwest Laboratory have been working toward the establishment of a new Molecular Science Research Center (MSRC). The primary scientific thrust of this new research center is in the areas of theoretical chemistry, chemical dynamics, surface and interfacial science, and studies on the structure and interactions of biological macromolecules. The MSRC will provide important new capabilities for studies on the structure of biological macromolecules. The MSRC program includes several types of advanced spectroscopic techniques for molecular structure analysis, and a theory and modeling laboratory for molecular mechanics/dynamics calculations and graphics. It is our goal to closely integrate experimental and theoretical studies on macromolecular structure, and to join these research efforts with those of the molecular biological programs to provide new insights into the structure/function relationships of biological macromolecules. One of the areas of structural biology on which initial efforts in the MSRC will be focused is the application of high-field, two-dimensional NMR to the study of biological macromolecules. First, we are interested in obtaining three-dimensional structural information on large proteins and oligonucleotides. Second, one of our primary objectives is to closely link theoretical approaches to molecular structure analysis with the results obtained in experimental research using NMR and other spectroscopies.

31548 The determination of UV-induced lesions in DNA by HPLC/GC. Ramsey, R.S. (Oak Ridge National Lab., TN (USA). Analytical Chemistry Div.); Ho, C.H.; Row, K.H. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1184.

Analytical methodology for quantitating photoproducts in DNA based on HPLC fractionation and electrophore labelling followed by GC/electron capture detection have been developed. Exposure of DNA to UV radiation results in the formation of a number of photoproducts of which the cyclobutyl pyrimidine dimers and the pyrimidine-pyrimidone (6–4) dimmers are the most abundant. The roles of these lesions in mutagenesis and carcinogenesis is still a controversial issue. At physiologically significant UV exposure, the concentrations of the dimers are only a small fraction of the corresponding DNA pyrimidine concentrations (0.05% or 5 in 10^5 nucleotides). These low levels, coupled with the small quantity of material usually available for analysis, require sensitive methods for accurate determination. Methods for analysis based upon a separation of the dimers from their monomers and from other constituents present in acid hydrolyzed DNA by reversed-phase HPLC have been developed. Three different analytical columns were examined: Adsorbosphere C_{18}, ODS-2, and Adsorbosphere phenyl. The ODS column was found to provide the most favorable separation with the uracil dimer and uracil-thymine dimer eluting before uracil and thymine dimer eluting prior to thymine. (Acid hydrolysis deaminates the cytosine to uracil). The dimeric fractions are collected from the HPLC and then derivatized to form pentafluorobenzyl products for analysis by a GC/ECD. The strong electron-capturing response yields detection limits in the low femtomole range. Details regarding the overall analytical scheme are presented.

31549 Mass spectrometry and MS/MS of large biomolecules with electrospray ionization. Loo, J.A. (Pacific Northwest Lab., Richland, WA (USA). Chemical Sciences Dept.); Barinaga, C.J.; Udseth, H.R.; Smith, R.D. vp. of Pittsburgh conference 1989 and exposition on analytical chemistry and applied spectroscopy (Abstracts). Pittsburgh Conference, Pittsburgh, PA (USA) (1989). (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989).

Abst. 1278.

Mass spectrometry with an atmospheric pressure electrospray ionization (ESI) source is an extremely soft ionization technique for biomolecules, even for molecular weights > 10,000 daltons. In addition to yielding little or no fragmentation, ESI has the ability to produce multiply charged molecular ions. For example, an ESI mass spectrum of ovotransferrin, a 77 kDa glycoprotein, shows a distribution of intact multiply charged molecular ions with the 73+ (multiply protonated) species as the most highly charged ion. A strong correlation is observed between the maximum number of charges and the number of basic amino acid residues (e.g., arginine, lysine, histidine, etc.). This multiple charging phenomenon allows mass spectrometers with a limited m/z (mass/charge) range to detect intact ions for compounds of much grater molecular weight. Multiply charged molecular ions of proteins with molecular weights greater than 130 kDa have been observed with a quadrupole mass spectrometer with a maximum m/z limit of 1700. Methods to shift the observed charge distribution to higher charge (lower m/z) or lower charge states are shown. Collisional activation of these multiply charged ions at elevated pressures by manipulation of the sampling nozzle-skimmer voltage bias are demonstrated. Structurally significant singly and multiply charged fragment ions have been obtained for large peptides and proteins by this method. Tandem mass spectrometry experiments of selected parent multiply charged ions yield singly and multiply charged sequence ions as well. The first examples of MS/MS for high molecular weight (>10 kDa) compounds are presented.

31550 Observation of cytoplasmic and vacuolar malate in maize root tips by ^{13}C-NMR spectroscopy. Chang, K. (Univ. of California, Riverside (USA)); Roberts, J.K.M. *Plant Physiology (USA)*, 89(1): 197-203 (Jan 1989).

The accumulation of malate by maize (Zea mays L.) root tips perfused with $KH^{13}CO_3$ was followed by ^{13}C nuclear magnetic resonance spectroscopy. In vivo nuclear magnetic resonance spectra contained distinct signals from two pools of malate in maize root tips, one at a pH ~5.3 (assigned to the vacuole) and one at a pH > 6.5 (assigned to the cytoplasm). The ratio of cytoplasmic to vacuolar malate was lower in 12 millimeter long root tips than in 2 millimeter root tips. The relatively broad width of the signals from C1- and C4-labeled vacuolar malate indicated heterogeneity in vacuolar pH. During the 3 hour $KH^{13}CO_3$ treatment, ^{13}C-malate accumulated first primarily in the cytoplasm, increasing to a fairly constant level of ~6 millimolar by 1 hour. After a lag, vacuolar malate increased throughout the experiment.

31551 A starch deficient mutant of Arabidopsis thaliana with low ADPglucose pyrophosphorylase activity lacks one of the two subunits of the enzyme. Lin, Tsanpiao (Michigan State Univ., East Lansing (USA)); Caspar, T.; Somerville, C.R.; Preiss, J. *Plant Physiology (USA)*, 88(4): 1175-1181 (Dec 1988). DOE Contract AC02-76ER01338.

A starch deficient mutant of Arabidopsis thaliana (L.) Heynh. has been isolated in which leaf extracts contain only about 5% as much activity of ADPglucose pyrophosphorylase (EC 2.7.7.27) as the wild type. A single, nuclear mutation at a previously undescribed locus designated adg2 is responsible for the mutant phenotype. Although the mutant contained only 5% as much ADPglucose pyrophosphorylase activity as the wild type, it accumulated 40% as much starch when grown in a 12 hour photoperiod. The mutant also contained about 40% as much starch as the wild type when grown in continuous light, suggesting that the rate of synthesis regulates its steady state accumulation. Immunological analysis of leaf extracts using antibodies against the spinach 54 and 51 kilodalton (kD) ADPglucose pyrophosphorylase subunits indicated that the mutant is deficient in a cross-reactive 54 kD polypeptide and has only about 4% as much as the wild type of a cross-reactive 51 kD polypeptide. This result and genetic studies suggested that adg2 is a structural gene which codes for the 54 kD polypeptide, and provides the first functional evidence that the 54 kD polypeptide is a required component of the native ADPglucose pyrophosphorylase enzyme.

31552 **Effect of 3′ flanking neighbors on kinetics of pairing of dCTP or dTTP opposite O^6-methylguanine in a defined primed oligonucleotide when Escherichia coli DNA polymerase I is used.** Singer, B. (Univ. of California, Berkeley (USA)); Chavez, F.; Goodman, M.F.; Essigmann, J.M.; Dosanjh, M.K. *Proceedings of the National Academy of Sciences of the United States of America (USA)*, 86(21): 8271-8274 (Nov 1989). DOE Contract AC03-76SF00098.

O^6-Methylguanine (m^6G) was incorporated site-specifically into two 25-base oligonucleotides differing only in the nucleotide on the 3′ side of the modified base. Escherichia coli DNA polymerase I (Klenow fragment) was used to determine the apparent K_m and relative V_{max} of incorporation of either dCTP or DTTP opposite m^6G or G. These data were used to calculate the relative frequency of incorporation opposite the m^6G or the unmodified G. When the sequence was 3′-Cm^{6}G-5′, there was a 6- to 7-fold preference for formation of a m^6G-T pair compared with m^6G-C. The m^6G-T frequency, based on V_{max}/K_m, was at least 50-fold greater than that of a G-T pair at the same site. Changing the sequence to 3′-Tm^{6}G-5′ had a marked effect on both K_m and V_{max} of pairs containing m^6G and on the incorporation frequency of T opposite m^6G, which was then only slightly favored over m^6G-C. When replication was started directly opposite m^6G, the kinetics appeared unaffected. These data indicate that the frequency of incorporation of C or T opposite m^6G in a DNA template is dependent on the flanking neighbors and that a change of even a single base at the 3′ position can have a major effect on mutagenic efficiency. It is concluded that, in the absence of repair, m^6G can exhibit widely differing mutation frequencies which, in these experiments, can be as high as 85% of the replicated based. This variation in frequency of changed pairing could contribute to the occurrence of mutational hot spots after replication of damage DNA.

5504 Genetics

Refer also to citation(s) 31544, 31545

5505 Metabolism

Refer also to citation(s) 29947, 29948

5506 Medicine

Refer also to citation(s) 30929, 31230

31553 (AD-A–217073/6/XAB) **NMR (nuclear magnetic resonance) imaging development for the study of solids. Final report, 27 August 1986-17 November 1989.** Suits, B.H. Michigan Technological Univ., Houghton, MI (USA). Dept. of Physics. 20 Dec 1989. 10p. Available from NTIS, PC A02/MF A01.

The techniques of nuclear magnetic resonance imaging are developed for simple inorganic solids and applied to the study of mechanically induced defects in NaC1. The feasibility of the technique is demonstrated for defect (dislocation) densities greater than 10 million/sq cm with a resolution of better than 1mm.

31554 (BNL–52205-Add.) **Safety Analysis Report: X17B2 beamline Synchrotron Medical Research Facility: An addendum to the Phase 2 NSLS Safety Analysis Report, BNL No. 52205, June 1989.** Gmuer, N.F.; Thomlinson, W. Brookhaven National Lab., Upton, NY (USA). Feb 1990. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90008241. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report contains a safety analysis for the X17B2 beamline synchrotron medical research facility. Health hazards, risk assessment and building systems are discussed. Reference is made to transvenous coronary angiography. (LSP)

31555 (DOE/ER/60039–T4) **[Development of gamma emitting, receptor-binding, radiotracers for imaging the brain and pancreas]: Progress report, March 1, 1987–February 28, 1988.** George Washington Univ., Washington, DC (USA). [1989]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-82ER60039. Order Number DE90010594. Available from NTIS, PC A03/MF A01 - OSTI.

This progress report covers the period from March 1, 1987 to Feb. 28, 1988. In studies to better understand the nature of the m-AChR receptor subtypes, we have generated a manuscript which has been submitted for publication in Life sciences entitled: The effect of chronic atropine and diisopropylfluorophosphate on rat brain muscarinic acetylcholine receptor subtype concentrations. We have also developed a more direct synthesis of 3-quinuclidinyl 4-iodobenzilate and its analogues. During this contract period, we have been involved with the synthesis of analogues 3-quinuclidinyl benzilate (QNB). We have determined the affinity constants of various compounds synthesized this year for the muscarinic receptor from rat corpus striatum. We have continued our investigation of the m-AChR in pancreas. 25 refs., 3 figs., 5 tabs.

31556 (DOE/ER/60487–4) **Development of more efficacious Tc-99m organ imaging agents for use in nuclear medicine by analytical characterization of radiopharmaceutical mixtures: Progress report, September 1, 1989–August 31, 1990.** Heineman, W.R. Cincinnati Univ., OH (USA). Dept. of Chemistry. Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER60487. Order Number DE90010034. Available from NTIS, PC A02/MF A01; OSTI; INIS.

A comprehensive study of the electrochemical generation of Tc-MDP complexes at reticulated vitreous carbon is in progress. Results thus far indicate that high yields of the same complexes that are formed by electrochemical generation at mercury electrodes and by chemical reduction by $NaBH_4$ at various values of solution pH are formed. Reticulated vitreous carbon offers the advantage of a flow through electrode with a large surface area for the rapid generation of Tc-MDP complexes at very low cost. It is a suitable electrode material for the proposed electrochemical syringe. A prototype TcO_4^- sensor has been fabricated by coating a graphite electrode with a thin film of the polymer poly(dimethyldiallylammonium chloride). The polymer concentrates electroactive anions at the electrode surface as demonstrated with ferricyanide and thereby enhances the analytical signal for their detection. 2 figs.

31557 (PB–90-174012/XAB) **Dynamic MRI (magnetic resonance imaging) reconstruction as a moment problem. Part 1. The beating heart: A problem formulation.** Zwaan, M. Centrum voor Wiskunde en Informatica, Amsterdam (Netherlands). Dept. of Algebra, Analysis and Geometry. c 1989. 18p. (CWI-AM-R–8905). Available from NTIS, PC A03/MF A01.

See also Part 2, PB–90-174020.

The paper deals with some mathematical aspects of magnetic resonance imaging (MRI) concerning the beating heart. MRI is used in diagnostic medicine to measure and display the cross section of a human organ. Some of the basic theory behind magnetic resonance is given. The author describes how a cross section of a beating human heart is measured in practice and how the measurements are arranged before an image can be made. The technique is called retrospective synchronization. If the beating heart is measured and displayed with help of this method, artefacts often deteriorate the image quality. Some of these artefacts have a

physical cause, while others are caused by the reconstruction algorithm. Perhaps mathematical techniques may be used to improve these algorithms which are currently used in practice. The aim of the paper is not to solve problems, but to give an adequate mathematical formulation of the inversion problem concerning retrospective synchronization.

5507 Microbiology

Refer also to citation(s) 29942, 29947, 29948, 29970, 30044, 30046, 30049, 30050, 30051, 30202, 30844

31558 (DOE/ER/60848–1) **Aquifer microcosms and in situ methods to test the fate and function of pollutant-degrading microorganisms.** Krumme, M.L. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Biotechnologie); Dwyer, D.; Thiem, S.M.; Tiedje, J.M.; Smith, R.L. Michigan State Univ., East Lansing, MI (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60848. Order Number DE90009956. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Little information is available on groundwater microorganism ecology, and specifically on the distribution and biochemical diversity of pollution degrading microorganisms in the aquifer. While the introduction of nutrients and electron acceptors may stimulate natural populations to degrade certain pollutants, low levels of pollutants and complex mixtures of pollutants may require the modification of natural populations through selective pressure or by means of genetic engineering. This study was designed to address these issues by examining three populations of substituted aromatic compound-degraders: an indigenous population, an introduced degrader, and a genetically engineered microorganism (GEM) in the environmental conditions of a sand and gravel aquifer. The goals of this study are to gain field experience on the fate and function of pollutant-degrading organisms in the aquifer and to evaluate column microcosms and survival chambers as tools for predicting the fate and function of selected and modified bacterial strains as appropriate aquifer bioremediation agents. 6 figs.

5510 Physiological Systems

31559 Structure of plant cell walls. Ishii, T. (Univ. of Georgia, Athens (USA)); Thomas, J.; Darvill, A.; Albersheim, P. *Plant Physiology (USA),* 89(2): 421-428 (Feb 1989).

Considerable information has been obtained about the primary structures of suspension-cultured sycamore (Acer pseudoplatanus) cell-wall pectic polysaccharides, i.e. rhamnogalacturonan I, rhamnogalacturonan II, and homogalacturonan. However, these polysaccharides, which are solubilized from the walls by endo-α-1,4-polygalacturonase, account for only about half of the pectic polysaccharides known to be present in sycamore cell walls. We now report that, after exhaustive treatment with endo-α-1,4-polygalacturonase, additional pectic polysaccharides were extracted from sycamore cell walls by treatment with Na_2CO_3 at 1 and 22°C. These previously uncharacterized polysaccharides accounted for ~4% of the cell wall. Based on the glycosyl and glycosyl-linkage compositions and the nature of the products obtained by treating the quantitatively predominant $NaCO_3$-extracted polysaccharides with lithium metal dissolved in ethylenediamine, the polysaccharides were found to strongly resemble rhamnogalacturonan I. However, unlike rhamnogalacturonan I that characteristically had equal amounts of 2- and 2,4-linked rhamnosyl residues in its backbone, the polysaccharides extracted in Na_2CO_3 at 1°C had markedly disparate ratios of 2- to 2,4-linked rhamnosyl residues. We concluded that polysaccharides similar to rhamnogalacturonan I but with different degrees of branching are present in the walls of suspension-cultured sycamore cells.

31560 Establishment of control parameters for in situ, automated screening of sustained hydrogen photoproduction by individual algal colonies. Graves, D.A. (Oak Ridge National Lab., TN (USA)); Reeves, M.E.; Greenbaum, E. *Plant Physiology (USA),* 87(3): 603-608 (Jul 1988). DOE Contract AC05-84OR21400.

An apparatus was constructed which allowed automated screening of individual microalgal colonies for sustained ability to photoevolve H_2 during anaerobic photosynthesis. The main components of this apparatus were a microcomputer, a He-Ne laser mounted on a computer-controlled X-Y translation stage, a flow-through chamber which contained an agar plate of colonies, and a H_2 detector which interfaced with the microcomputer for data collection. The system was capable of detecting a minimum production rate of 1 nanomole of H_2 per hour per colony and provided an efficient means of screening relatively large numbers of algal colonies. Examination of the effect of the spacing of colonies on the agar plate, light intensity, stability of colonies within a screening period, colony age, chlorophyll content, and colony size on H_2 yield indicated that, under optimum conditions, yields from genetically uniform colonies varied by no more than a factor of 2 in their H_2-producing ability. Therefore, colonies of algae whose H_2 yields lie outside this intrinsic twofold variability can be identified and selected as natural variants or mutants. A description of the construction and of the apparatus is presented, and the experimental results used to establish the control parameters for Chlamydomonas reinhardtii colonies are discussed.

31561 Enzymic cross-linkage of monomeric extensin precursors in vitro. Everdeen, D.S. (Michigan State Univ., East Lansing (USA)); Kiefer, S.; Willard, J.J.; Muldoon, E.P.; Dey, P.M.; Li, Xiongbiao; Lamport, D.T.A. *Plant Physiology (USA),* 87(3): 616-621 (Jul 1988). DOE Contract AC02-76ER01338.

Rapidly growing tomato (Lycopersicon esculentum) cell suspension cultures contain transiently high levels of cell surface, salt-elutable, monomeric precursors to the covalently cross-linked extensin network of the primary cell wall. Thus, the authors purified a highly soluble monomeric extensin substrate from rapidly growing cells, and devised a soluble in vitro cross-linking assay based on Superose-6 fast protein liquid chromatography separation, which resolved extensin monomers from the newly formed oligomers within 25 minutes. Salt elution of slowly growing (early stationary phase) cells yielded little or no extensin monomers but did give a highly active enzymic preparation that specifically cross-linked extensin monomers in the presence of hydrogen peroxide, judging from: (a) a decrease in the extensin monomer peak on fast protein liquid chromatography gel filtration, (b) appearance of oligomeric peaks, and (c) direct electron microscopical observation of the cross-linked oligomers. The cross-linking reaction had a broad pH optimum between 5.5 and 6.5. An approach to substrate saturation of the enzyme required extensin monomer concentrations of 20 to 40 milligrams per milliliter. Preincubation with catalase completely inhibited the cross-linking reaction, which was highly dependent on hydrogen peroxide and optimal at 15 to 50 micromolar. They therefore identified the cross-linking activity as extensin peroxidase.

31562 Frequency distribution histograms for the rapid analysis of data. Burke, P.V. (Michigan State Univ., East Lansing (USA)); Bullen, B.L.; Poff, K.L. *Plant Physiology (USA),* 87(4): 797-798 (Aug 1988). DOE Contract AC02-76ER01338.

The mean and standard error are good representations for the response of a population to an experimental parameter and are frequently used for this purpose. Frequency distribution histograms show, in addition, responses of individuals in the population. Both the statistics and a visual display of the distribution of the responses can be obtained easily using a microcomputer and available programs. The type of distribution shown by the histogram may suggest different mechanisms to be tested. The data for the frequency distributions presented here were generated with an IBM PC computer using a program written in C. The algorithm generates data by randomly sampling Gaussian distributions with the prescribed means and standard deviations. The data have been assigned to the appropriate bin, and the frequency distributions have been constructed and printed using VP-planner (Stephenson Software Inc.). The abscissa for these frequency distributions has been set equal to degrees curvature to model the curvature of plant shoots exposed to a phototropic or gravitropic stimulus.

31563 Cytoplasmic membrane changes during adaptation of the fresh water cyanobacterium Synechococcus 6311 to salinity. Lefort-Tran, M. (Laboratoire de Bioenergetique Cellulaire et Cytophysiologie, Gif-sur-Yvette (France)); Pouphile, M.; Spath, S.; Packer, L. *Plant Physiology (USA),* 87(3): 767-775 (Jul 1988).

In this investigation, changes were characterized in cell structure and cytoplasmic membrane organization that occur when the freshwater cyanobacterium Synechococcus 6311 is transferred from low salt (0.03 molar NaCl) to high salt (0.5 molar NaCl) media (i.e. sea water concentration). Cells were examined at several time points after the imposition of the salt stress and compared to control cells, in thin sections and freeze fracture electron microscopy, and by flow cytometry. One minute after exposure to high salt, i.e. salt shock, virtually all intracellular granules disappeared, the density of the cytoplasm decreased, and the appearance of DNA material was changed. Glycogen and other granules, however, reappeared by 4 hours after salt exposure. The organization of the cytoplasmic membrane undergoes major reorganization following salt shock. Freeze-fracture electron microscopy showed that small intramembrane particles (diameters 7.5 and 8.5 nanometers) are reduced in number by two- to fivefold, whereas large particles, (diameters 14.5 and 17.5 nanometers) increase two- to fourfold in frequency, compared to control cells grown in low salt medium. The changes in particle size distribution suggest synthesis of new membrane proteins, in agreement with the known increases in respiration, cytochrome oxidase, and sodium proton exchange activity of the cytoplasmic membrane.

31564 Correlation of stomatal conductance with photosynthetic capacity of cotton only in a CO_2-enriched atmosphere: Mediation by abscisic acid?. Radin, J.W. (Western Cotton Research Lab., Phoenix, AZ (USA)); Hartung, W.; Mauney, J.R.; Kimball, B.A. *Plant Physiology (USA),* 88(4): 1058-1062 (Dec 1988).

Some evidence indicates that photosynthetic rate (A) and stomatal conductance (g) of leaves are correlated across diverse environments. The correlation between A and g has led to the postulation of a messenger from the mesophyll that directs stomatal behavior. Because A is a function of intercellular CO_2 concentration (c_i), which is in turn a function of g, such a correlation may be partially mediated by c_i if g is to some degree an independent variable. Among individual sunlit leaves in a cotton (Gossypium hirsutum L.) canopy in the field, A was significantly correlated with g. The relative photosynthetic capacity of each leaf was calculated as a measure of mesophyll properties independent of c_i. This approach revealed that, in the absence of c_i effects, mesophyll photosynthetic capacity was unrelated to g. When plants were grown in an atmosphere enriched to about 650 microliters per liter of CO_2, however, photosynthetic capacity remained strongly correlated with g even though the procedure discounted any effect of variable c_i. This residual correlation implies the existence of a messenger in CO_2-enriched plants. Enriched CO_2 also greatly increased stomatal response to abscisic acid (ABA) injected into intact leaves. The data provide no evidence for a messenger to coordinate g with A at ambient levels of CO_2. In a CO_2-enriched atmosphere, though, ABA may function as such a messenger because the sensitivity of the system to ABA is enhanced.

5530 Agriculture and Food Technology

Refer also to citation(s) 30894, 30895, 30927, 31348, 31452

31565 (CNIC–00179) **Study on dynamics of the growth and multiplication of leukemia cell lines with ^{3}H-TdR incorporation method.** Yang Jicheng (Suzhou Medical Coll., JS (China)); Liu Jingshan; Zhang Lansheng; Xu Hongzhen. China Nuclear Information Centre, Beijing, BJ (China). Mar 1988. 5p. (In Chinese). (SMC–0020). Order Number DE90626546. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Dynamics and the generation time of growth and multiplication in S_{801} and S_{7811} leukemia cell lines established by Suzhou Medical College were determined with ^{3}H-TdR incorporation method. Results of these have shown that the first midpoint of S phase appeared in 13 ≈ 14 of incubation, while the second one did in 32 ≈ 33 h of that for S_{801} leukemia cell line. Its generation time was for about 19 ≈ 20 h. The first midpoint of S phase appeared in 16 ≈ 17 h and the second one in 28 ≈ 29 h for S_{7811} leukemia cell line, while its generation time was for about 12 ≈ 13 h. These dynamics of S_{801} and S_{7811} leukemia cell lines may be of the same characterization of S_{801} cell line as one of the normal human leukocytes, however, S_{7811} cell line appears to be a malignant tumor cell.

31566 (CNIC–00200) **Study on the improvement of mutagenic rate in wheat by radiation.** Wang Jinxiang (Shanxi Academy of Agricultural Sciences, Taiyuan (China). Inst. of Agricultural Physics). China Nuclear Information Centre, Beijing, BJ (China). Apr 1988. 12p. (In Chinese). (A14-IAP–0020). Order Number DE90626528. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The experiment to improve the effect of radiation breeding of wheat includes three treatments: (a) multiple treament, i. e. gamma irradiation and then VEL-14 type microwave oscillator for 5 ≈ 15 minutes, (b) irradiating the dried sees under the condition of nitrogen gas and (c) immersing in rapeseed-dipping solution, then irradiation after drying. The biological effect of M_1 after irradiation was observed and mutation frequency and mutation type of M_2 were investigated. The results showed the three treatments have the common effects reducing radiation damage and increasing normal plant proportion by 10 ≈ 300%, and they provided sufficient M_1 plants, increased the mutation frequency of M_2 by 20 ≈ 100% and improed its selection probability.

31567 (IAEA-TECDOC–539) **Guidelines for industrial radiation sterilization of disposable medical products (Cobalt-60 gamma irradiation).** International Atomic Energy Agency, Vienna (Austria). Jan 1990. 39p. Order Number DE90626559. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This IAEA document is aimed at providing necessary guidance on standards and criteria and assistance to Member States, particularly developing countries, in their attempts to properly set up facilities for industrial radiation sterilization of duly-manufactured medical products by exposure to Co-60 gamma radiation. The contents of the guidelines have therefore been designed, as far as practicable, to reflect the practices and procedures currently employed in the processing of the majority of the radiation-sterilized medical products being produced worldwide. Consequently, this document has attempted to present to its users, for information and for action, all the relevant features of the standard criteria as are currently in existence under the auspices of the various authoritative national and/or regional Codes or Guides. The potential user(s) from Member States are expected to freely decide which of the various standards as enumerated in the Guidelines document should be considered for inclusion or exclusion either partially or totally in the context of the formulation of their own nationally-acceptable guidelines. Refs and tabs.

31568 (PB–90-862095/XAB) **Corn starch: Properties and processing. January 1972-December 1987 (a Bibliography from the Food Science and Technology Abstracts data base). Report for January 1972-December 1987.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 180p. Available from NTISPC N01/MF N01.

See also PB–90-862103.

This bibliography contains citations concerning corn-starch processing. The physical and chemical properties, and nutritive value of corn starch and corn starch products are considered. Studies of gamma-irradiated corn starch are included. (This updated bibliography contains 397 citations, none of which are new entries to the previous edition.)

31569 (PB–90-862103/XAB) **Corn starch: Properties and processing. January 1988-February 1990 (a Bibliography from the Food Science and Technology Abstracts data base). Report for January 1988-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 58p. Available from NTISPC N01/MF N01.

Supersedes PB–88-854872. See also PB–90-862095.

This bibliography contains citations concerning corn-starch processing. The physical and chemical properties, and nutritive value of corn starch and corn starch products are considered. Studies of gamma-irradiated corn starch are included. (This updated bibliography contains 107 citations, all of which are new entries to the previous edition.)

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 30155, 31396, 31425, 31432, 31433, 31452, 31454, 31477

31570 (AD-A-217649/3/XAB) **Investigation of the potential of 31-phosphorus nuclear magnetic resonance spectroscopy to predict radiation sensitivity. Doctoral thesis.** Bowser, C. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). 1988. 108p. (AFIT/CI/CIA-88-226). Available from NTIS, PC A06/MF A01.

The ability of in vivo 31-Phosphorus Nuclear Magnetic Resonance (31-PNMR) Spectroscopy to predict radiation sensitivity following both single and fractionated therapy was evaluated in this study. For Radiation Induced Fibrosarcoma (RIF-1) tumors either, in their natural state or treated with the vasodilator, hydralazine, an increase in the ratio of phosphocreatine to inorganic phosphate (PCr/Pi) and tumor pH were shown to be significantly correlated ($p < 0.01$) with radiation sensitivity to a single dose of 15 Grays (Gy) of radiation. After administration of hydralazine to reduce tumor blood flow or flunarizine to increase tumor blood flow, time dependent changes were observed in the 31-P NMR spectrum. After hydralazine, there was a significant ($p < 0.01$) decrease in PCr/Pi over time. The opposite pattern was seen for flunarizine i.e., decline in Pi, and an increase tumors was substantially greater ($p < 0.05$) than that of hydralazine treated tumors.

31571 (BS-8502/1) **Investigation of indoor-inhalation exposure due to nuclear accidents. Final report.** Brenk, H.D. Brenk Systemplanung Ingenieurbuero fuer Wissenschaftlich-Technischen Umweltschutz, Aachen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Apr 1987. 120p. (In German). Contract BMFT 1500 736 4. Available from Copy held by UB/TIB Hannover.

The report provides an improved data base with respect to indoor inhalation eposure after severe accidents in nuclear facilities. The improvement was achieved by an extensive exploration of the related literature, both in the nuclear and in the field of chemical toxicants. The results in terms of dose reduction factors due to inhalation of indoor instead of outdoor air is presented for two cases: without any emergency-related counter measures and for a case with protection measures, such as closing of all doors and windows and switching air conditioning equipments to recirculation during cloud passage, and intensive airing afterwards. Depending on the physico-chemical form of the radionuclides and specific room categories, reduction factors show a range between 0.004 and 1. (orig./HP).

31572 (CNIC-00233) **Study on the metabolism of contamination of radioactive materials in organism by autoradiographic techniques.** Zhu Shoupeng (Suzhou Medical Coll., JS (China)); Zhang Lansheng; Kang Baoan. China Nuclear Information Centre, Beijing, BJ (China). Aug 1988. 9p. (In Chinese). (SMC-0025). Order Number DE90626498. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The metabolism of contamination of radioactive materials in organism was studied by diferent types of autoradiographic techniques, such as: (1) in body level by whole-body autoradiography; (2) in organ level by whole-organ autoradiography; (3) in cellular level by microautoradiography; (4) in subcellular level by electron microscopic autoradiography; (5) in combinative form by tissue fixative autoradiography; (6) in ionizing form by freezing autoradiography; (7) for radioactive mateials with two radionuclides by double radionuclide autoradiography; (8) for radioactive materials with low level of radionuclides by fluorescence sensitization autoradiography; (9) in dissociative products by chromatographic autoradiography.

31573 (CNIC-00259) **A study on experimental toxicology of ^{147}Pm in rat.** Zhao Jingyong (Suzhou Medical Coll., JS (China)); Lao Qinhua. China Nuclear Information Centre, Beijing, BJ (China). Nov 1988. 13p. (In Chinese). (SMC-0026). Order Number DE90626499. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The absorb law of ^{147}Pm by pulmonary compartment, intestines and skin of rat is reported. The metabolic pattern of ^{147}Pm in rat and its dose model are worked out on the basis of measured data. The injurious effects of the nuclide were observed by using $LD_{50/60}$, micro-nucleus rates of lymphocytes in peripheral blood and activity of SGPT in serum as indices.

31574 (CNIC-00264) **Study of the effect of ^{60}Co γ-rays on lymphocyte subsets with monoclonal antibodies (McAb) and pokeweed mitogen (PWM).** Xu Yingdong (Suzhou Medical Coll., JS (China)); Su Liaoyuan; Liu Keliang. China Nuclear Information Centre, Beijing, BJ (China). 1989. 11p. (In Chinese). (SMC-0028). Order Number DE90626347. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The efect of ^{60}Co γ-rays on the lymphocytes were investigated with T_4, T_8, and HI_4, McAbs. T and B lymphocytes were separated by rosetting procefures. After lymphocytes were labelled by T_4 McAb, T_4^+ and non-T_4^+ cells were obtained by cell affinity chromatography method. When parts of T, B, T_4^+ and non-T_4^+ cells were exposed to 10 Gy ^{60}Co γ-rays, the stimulating function of pokeweed mitogen and the effect of ^{60}Co γ-rays on lympocytes were observed by technique of ^{3}H-TdR incorporation. The results showed that when T_4^+, T_8^+ and HI_{43}^+ cells were labelled after irradiation at a dose of 0.1 Gy within one hour, the number of positive cells decreased significantly. The cells radiosensitivity in the group of T_8^+, and HI_{43}^+ lympocytes. PWM can stimulate both T and B cells but B cells were more sensitive to PWM. The response of B cells to PWM was the same as that of non-T_4^+ cells. The response of B lympocytes but such a kind of synergistic effect in T cell were irradiated by 10 Gy ^{60}Co γ-rays, their synergistic effect disappeared. Neither synergistic nor suppressive effect was found between the cells in B group and non-T_4^+ group. When T_4^+, B and non-T_4^+ cells had been exposed to 10 Gy irradiation, the decreasing value of ^{3}H-TdR incorporation in B and non-T_4^+ cells had no significant difference but their decreasing value was more obvious than that in T_4^+ group.

31575 (CNIC-00275) **Behaviour of fission products ^{90}Sr, ^{137}Cs and ^{144}Ce in soil-plant system.** Zhu Yongyi (Chinese Academy of Agricultural Sciences, Beijing, BJ (China). Inst. for Application of Atomic Energy); Qiu tongcai. China Nuclear Information Centre, Beijing, BJ (China). Nov 1988. 9p. (In Chinese). (AC-IAAE-0023). Order Number DE90626500. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A small quantity of radioonuclides, such as fission products ^{90}Sr, ^{137}Cs and ^{144}Ce etc., generally may leak out from nuclear industry system and may be disseminated on soul and plant cover. The accumulation and distribution of the radionuclides in spring wheat planted in the contaminated soil are described. The factors as nuclide chemical forms, soil agrochemical properties, growing stages of the plant and fertilizing etc., which affect the accumulation and the distribution were discussed. Possible approches were supposed to eliminate or clean the radionuclides from contaminated soil, which include planting adaptable herbage, applying some fertilizers and scraping regolith etc.

31576 (CNIC-00286) **The traffic and homing of lymphocytes in rats and lymphoblasts in mice and the radiation effects on the process.** Yang Huibin (Suzhou Medical Coll., JS (China)); Xie Ping; Yin Zhiwei; Zhu Jingwei; Mao Zijun. China Nuclear Information Centre, Beijing, BJ (China). Dec 1988. 8p. (In Chinese). (SMC-0029). Order Number DE90626348. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

In vitro ^{60}Co γ-ray irradiation of ^{51}Cr or ^{3}H-UR-labeled lymphocytes from rat spleen and ^{3}H-TdR-labeled lymphoblasts from mouse mesenteric lympho nodi (MLN) was found to alter their subsequent in vivo distribution significantly in syngeneic rats and mice using techniques of γ-counting and liquid scintillation counting in combination with autoradiography. The experimental results suggested as follows: Irradiated lymphocytes demonstrated an increased distribution to the liver, lungs and spleen. Cells going to the MLN and gut-associated lymphoid tissues (GALT) showed a significant decrease in homing following irradiation. The effects of

^{60}Co γ-rays on the lymphocyte and lymphoblast traffic and homing were related to the radiation doses. There was a significant inhibiting effect on the ability of selective homing of MLN lymphoblasts to GALT and intestinal mucosa with doses over 4 Gy, while the selective homing of splenic lymphocytes was affected after 0.5 Gy exposure. The autoradiography showed that the migration of the irradiated lymphocytes into B cell areas of MLN and spleen was depressed more remarkably than that into T cell areas. These studies provide some experimental materials for radiation immunology.

31577 (EUR–12064) **Radiation protection programme progress report 1988.** Commission of the European Communities, Luxembourg (Luxembourg). 1988. 196?p. (In DE, EN, FR). Contract BI6-A-005-F. Available from NTIS (US Sales Only), PC A99/MF A01.

The progress report of the radiation protection programme outlines the research work carried out in 1988 under contracts between the Commission of the European Communities and research groups in the Member States. Results of more than 350 projects are reported. They are grouped into six sectors: Radiation dosimetry and its interpretation; Behaviour and control of radionuclides in the environment; Nonstochastic effects of ionizing radiation; Radiation carcinogenesis; Genetic effects of ionizing radiation; Evaluation of radiation risks and optimization of protection. Within the framework programme, the aim of this scientific research is to improve the conditions of life with respect to work and protection of man and his environment and to assure a safe production of energy, i.e.: (i) to improve methods necessary to protect workers and the population by updating the scientific basis for appropriate standards; (ii) to prevent and counteract harmful effects of radiation; (iii) to assess radiation risks and provide methods to cope with the consequences of radiation accidents.

31578 (GSF–13/89) **Development and improvement of four submodels for accident consequence calculations (phase B of DRS). Final report. Pt. 2. External radiation exposure.** Jacobi, W.; Paretzke, H.G.; Jacob, P.; Meckbach, R. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Nov 1989. 187p. (In German). Contract BMFT 15006846. Order Number DE90785000. Available from NTIS (US Sales Only), PC A09/MF A01.

To improve the external dose model of the German risk study dose equivalents in 22 organs of anthropomorphical phantoms have been calculated for exposure to radionuclides in the air and on the ground. The angular and energy dependence of the photon fluence, the surface roughness of the ground and the migration of radionuclides in soil have been taken into account. For cloud radiation the organ doses in the new calculations are lower than in phase A, particulary for the red marrow and the bones. For exposures to deposited radionuclides the new results are higher, especially for the lungs and the thyroid ($\simeq$ 40%) and the gonads ($\simeq$ 60%). Due to the inclusion of the contribution of daughter nuclides the doses from Te-132 and Ba-140 are higher by an order of magnitude. Migration of important radionuclides in soil have been new modelled. The respective reduction of doses in the first 70 years after deposition is smaller by a factor of 1.5. To determine the shielding by houses and urban environments Monte Carlo simulations of the photon transport have been performed. It was found, that for cloud radiation the exposition outside in urban areas, in large buildings and in basements have been over-estimated in Phase A. The shielding of radiation from surface contaminations is different for wet and dry deposition. The relatively high dry deposition on trees can lead to exposures in suburban areas, twice as much as over lawns. Living rooms are in general better shielded than previously assumed. (orig./HP).

31579 (GSF–14/89) **Development and improvement of four submodels for accident consequence calculations (phase B of DRS). Final report. Pt. 3. Dose conversion factors for internal emitters and contaminations of the skin.** Jacobi, W.; Paretzke, H.G.; Henrichs, K. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Nov 1989. 298p. (In German). Contract BMFT 15006846. Order Number DE90785001. Available from NTIS (US Sales Only), PC A13/MF A01.

This report describes the derivation of dose conversion factors for the calculation of organ doses. To calculate internal exposures for the general population it is necessary to take into account the influence of the age dependence of biokinetic and anatomic parameters. Dose conversion factors were calculated for six different ages for all radionuclides of possible importance in the case of a reactor accident. These factors were derived for 19 organs and for up to three chemical compounds per radionuclide. Dose conversion factors were derived for the 50-year-committed dose equivalent and for ten additional times after incorporation. These values help with the assessment of acute health consequences of a radionuclide incorporation but also to take into account the influence of this temporal distribution on the frequency of late somatic effects. For few radionuclides biokinetic data are available which are sufficient to estimate the reliability of the corresponding dose factors. For these nuclides the 95%-percentiles of the organ doses are estimated to lie between 1.6 and 3.5 times the calculated reference doses. For radioactive contaminations of the skin dose conversion factors were calculated for skin layers in various depths and additionally for 19 other organs of the human body taking into account the possibly occuring penetration of radioactivity into deeper layers of the skin. (HP).

31580 (GSF–15/89) **Development and improvement of four submodels for accident consequence calculations (phase B of DRS). Final report. Pt. 4. Somatic late effects of ionizing radiation.** Jacobi, W.; Paretzke, H.G.; Chmelevsky, D.; Gerken, M.; Henrichs, K.; Schindel, F. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Nov 1989. 229p. (In German). Contract BMFT 15006846. Order Number DE90785002. Available from NTIS (US Sales Only), PC A11/MF A01.

Under the assumption of a relative-temporal-risk-model (with a constant factor of proportionality) and of a linear dose-response-relationship, the overall risk-factor for the German population was estimated to be about 5% per Sv. The tentative inclusion of the revised data of the Japanese atomic-bomb-survivors could lead to an estimate of 7$\pm$4% per Sv, even at low cumulative doses and low dose-rates. The radiosensitivity of children with ages below 10 years seems to be about a factor of 3 to 5 higher than that of juveniles and adults. The relative risk among women is significantly higher as compared to that of men, whereas the absolute risks are comparable. The most important uncertainties are due to the extrapolation of the observed risks to low levels of doses and low dose-rates, to the temporal risk-projection and to the transportation of risks between different populations. (HP).

31581 (ORNL/M–1164) **A technical review and assessment of the BEIR [Biological Effects of Ionizing Radiation] V report.** Oak Ridge National Lab., TN (USA). Mar 1990. 69p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010430. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report was prepared by the DOE BEIR V Technical Review Committee (TRC) to provide a technical review and assessment of the National Research Council's Biological Effects of Ionizing Radiation (BEIR) Committee's Report entitled "Health Effects of Exposure to Low Levels of Ionizing Radiation" (BEIR V). This report contains seven sections. The first section serves as an introduction and reviews the charge to the TRC. The second section is a chapter-by-chapter summary of the BEIR V Report. The third section is a summary of the risk estimates and conclusions of the BEIR V Committee for genetic effects, cancer induction, and in utero effects. The fourth section is a summary and analysis of the new scientific information used by the BEIR V Committee in developing its risk recommendations and conclusions. The fifth section is an assessment of the scientific information and methods used by the BEIR V Committee in developing their risk estimates and conclusions and an analysis of the key assumptions underlying the use of these risk estimates in risk assessment. The sixth section is the TRC's assessment of the regulatory implications of the BEIR V risk estimates and conclusions for DOE nuclear operations. The

seventh and final section is the TRC's recommended actions for DOE's consideration concerning the BEIR V Report risk estimates and conclusions.

31582 (PB–90-180142/XAB) **Collaborative Radiological Health Laboratory annual report, 1988: Health effects of prenatal and postnatal whole-body exposure to ionizing radiation in the beagle dog.** Colorado State Univ., Fort Collins, CO (USA). Collaborative Radiological Health Lab. Sep 1989. 83p. Available from NTIS, PC A05/MF A01.

See also report for 1987, PB–89-187272.

The Collaborative Radiological Health Laboratory was established in 1962 by the U.S. Public Health Service and Colorado State University for the purpose of determining, in a carefully controlled animal experiment, the life-time hazards associated with prenatal and early postnatal exposure to ionizing radiation. The CRHL study is designed to provide information that will facilitate the evaluation of risks to human beings from medical exposure during early development. This is a long-term (life span) study of a moderately large and long-lived mammal exposed at one of several times during development to a relatively small and discrete dose of external radiation. Ages-at-irradiation selected for comparison reflect the primary concern with medical exposures during the developmental period. The basic experiment under the contract contains 1,680 beagles that will be maintained and evaluated for most of their natural lives. Commitment of animals began in December 1967 and was completed in February 1973. The annual report summarizes the current status of the study for the reporting period of November 21, 1987 through November 20, 1988.

31583 (PB–90-861691/XAB) **Biological effects of radiation accidents on humans. September 1970-February 1990 (a Bibliography from the NTIS data base). Report for September 1970-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 124p. Available from NTISPC N01/MF N01.

Supersedes PB–88-852801.

This bibliography contains citations concerning the impact of radiation accidents on humans. Radiation exposure assessment for determining appropriate medical treatment is discussed. The effects of ingesting food or inhaling air irradiated by accident fallout are considered. Follow-up studies of the survivors of specific nuclear accidents are included in an attempt to evaluate long and short term health effects of accidents. (This updated bibliography contains 224 citations, 62 of which are new entries to the previous edition.)

31584 (PNL–7307) **Performance testing of radiobioassay laboratories: In vivo measurements: Final report.** MacLellan, J.A.; Traub, R.J.; Olsen, P.C. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 102p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90008225. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A study of two rounds of in vivo laboratory performance testing was undertaken by Pacific Northwest Laboratory (PNL) to determine the appropriateness of the in vivo performance criteria of draft American National Standards Institute (ANSI) standard ANSI N13.3, "Performance Criteria for Bioassay." The draft standard provides guidance to in vivo counting facilities regarding the sensitivity, precision, and accuracy of measurements for certain categories of commonly assayed radionuclides and critical regions of the body. This report concludes the testing program by presenting the results of the Round Two testing. Testing involved two types of measurements: chest counting for radionuclide detection in the lung, and whole body counting for detection of uniformly distributed material. Each type of measurement was further divided into radionuclide categories as defined in the draft standard. The appropriateness of the draft standard criteria by measuring a laboratory's ability to attain them were judged by the results of both round One and Round Two testing. The testing determined that performance criteria are set at attainable levels, and the majority of in vivo monitoring facilities passed the criteria when complete results were submitted. 18 refs., 18 figs., 15 tabs.

31585 (SNV–3125) **Influence of temperature on detachment of radionuclides from perches (Perca Fluviatilis).** Notter, M. (Statens Naturvaardsverk Oeregrund (Sweden). Laboratoriet foer Miljoekontroll); Nyman, B. Statens Natuurvaardsverk, Solna (Sweden). 1989. 31p. (In Swedish). Order Number DE90626502. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The uptake and elemination of radionuclides in perch were studied at two temperatures. The investigated nuclides were Mn-54, Co-60, Zn-65, Tc-95m, Ce-114 and Eu-155. One-year-old perches accumulated radionuclides from the water phase for 14 days at 15 degree C. After that they were divided in two groups for the elimination studies at 15 degree C and 5 degree C. The elimination experiment were carrried out in aquaria with running water, with a salinity of 5 permillage. The perches were fed with uncontaminated worms during the elimination period. Each fish had been marked before the contamination by fin cutting, and was now followed during the elimination by 'in vivo' measurements until they died. The concentration of radionuclides in the aquaria declined during the uptake. High losses were measured for Ce-144 (89%) and Eu-155 (83%), while the main part of Ag-110m (86%), Zn-65 and Tc-95m (65%) remained in the water phase. The greater of the radionuclides were rapidly eliminated from the fishes and only for Zn-65 (71%) and for Co-60 (54%) was more than 40% remaining after 20 days elimination. The elimination is about 2.5 time faster at 15 degree C than at 5 degree C. (10 figs., 7 tabs., 31 refs.).

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Refer also to citation(s) 30033, 30065, 30067, 30068, 30717, 31358, 31385, 31398, 31399, 31400, 31402, 31403, 31407, 31458, 31459, 31535, 31541, 31542, 31564

31586 (AD-A–217217/9/XAB) **Hydrogen/sulfur metabolism in the hyperthermophilic archaebacterium, pyrodictium brockii. Annual report, 19 January 1989-18 January 1990.** Kelly, R.M. Johns Hopkins Univ., Baltimore, MD (USA). Dept. of Chemical Engineering. 22 Jan 1990. 7p. Available from NTIS, PC A02/MF A01.

The objective of this work is to understand the relationship between hydrogen uptake and sulfur reduction as it relates to the energetics of the hyperthermophilic archaebacterium, Pyrodictium brokii. In the first year of work, we have shown that P. brockii apparently uses a soluble sulfur species (i.e., a polysulfide) as a substrate for sulfur reduction. Also, we have established protocols for growing this organism in continuous culture under conditions such that molecular hydrogen, the energy substrate, is growth-limiting. It was also shown that several metals (chromium, nickel, molybdenum) were toxic at the 10 ppm level necessitating the use of an all glass system for cultivation. In the second year of work, we plan to estimate maintenance energies and growth efficiencies for P. brockii using an unstructured mathematical model for cell growth, substrate consumption and gaseous product formation. Also, we will investigate the relationship between growth, hydrogen and carbon dioxide uptake, and sulfide generation.

31587 (AD-A–217264/1/XAB) **Acute oral toxicity of JA-2 solid propellant in icr mice. Report for 17 December 1985-17 January 1986.** Morgan, E.W.; Frost, D.F.; Wheller, C.R.; Korte, D.W. Letterman Army Inst. of Research, San Francisco, CA (USA). Dec 1989. 73p. (LAIR–414). Available from NTIS, PC A04/MF A01.

The acute oral toxicity of JA-2 Solid Propellant was determined in male and female ICR mice by using an oral gavage, split-dose method. The MLD was 3774.6 + or - 150.5 mg/kg for male mice and 3528.8 + or - 133.8 mg/kg for female mice. JA-2 produced component, diethyleneglycol dinitrate and nitroglycerin. These signs included tremors, inactivity, depression of reflexes, loss of equilibrium, opisthotonus, and increased respiratory activity. Other clinical signs observed were associated with the general malaise of the animals following dosing and included perianal staining, hunched posture, squinting, and rough coat. Most animals exhibited signs by 2 hours after dosing and either had died or the signs had cleared within 5 days of dosing. According to the classification scheme of Hodge and Sterner, these results place JA-2 in the slightly toxic class.

31588 (AD-A–217345/8/XAB) **Acute dermal toxicity of guanidine hydrochloride in rabbits. Report for 18 May-1 August 1984.** Hiatt, G.F.; Sanso, S.K.; Korte, D.W. Letterman Army Inst. of Research, San Francisco, CA (USA). Dec 1989. 31p. (LAIR–419). Available from NTIS, PC A03/MF A01.

The acute dermal toxicity of guanidine hydrochloride was evaluated in five male and five female New Zealand White rabbits. Guanidine hydrochloride (2 g/kg) was applied topically to the clipped dorsal skin surface for 24 hours. No compound-related deaths or clinical signs were observed; however, guanidine hydrochloride did produce dermal irritation, necrosis, and eschar formation under conditions of the study.

31589 (AD-A–217346/6/XAB) **Dermal sensitization potential of ja-2 solid propellant in guinea pigs. Report for 4 April-9 May 1986.** Lewis, C.M.; Brown, L.D.; Korte, D.W. Letterman Army Inst. of Research, San Francisco, CA (USA). Nov 1989. 42p. (LAIR–417). Available from NTIS, PC A03/MF A01.

JA-2 Solid Propellant was evaluated for its potential to produce dermal sensitization in male guinea pigs. The Buehler test, which utilizes repeated closed patch inductions with the test compound, was used for this evaluation. No evidence that JA-2 Solid Propellant induced sensitization was obtained in the study.

31590 (AD-A–217347/4/XAB) **Acute oral toxicity of ja-2 solid propellant in sprague-dawley rats. Report for 12 November-19 December 1985.** Brown, L.D.; Justus, J.D.; Wheeler, C.R.; Korte, D.W. Letterman Army Inst. of Research, San Francisco, CA (USA). Dec 1989. 75p. (LAIR–412). Available from NTIS, PC A04/MF A01.

The acute oral toxicity of JA-2 Solid Propellant was determined in male and female Sprague-Dawley rats by using an oral gavage split-dose method. The MLD was 3990.6 + or - 349.7 mg/kg for male rats and 2545.9 + or - 421.1 mg/kg for female rats. JA-2 produced clinical signs that were attributed to its nitrate ester components, diethyleneglycol dinitrate and nitroglycerin. These signs included tremors and twitching, cyanosis, and increases in respiratory rate and depth. Other clinical signs observed were associated with the general malaise of the animals following dosing and included hunched posture, rough coat, reddish stains around the eyes and nose, and perianal staining. Most animals exhibited signs by 4 hours after dosing and either had died or the signs had cleared by 96 hours after dosing. According to the classification scheme of Hodge and Sterner, these results place JA-2 in the slightly toxic class.

31591 (CWS/SF–67E) **Studies of the effect of acidification on aquatic wildlife in Canada: Lacustrine birds and their habitats in Quebec.** DesGranges, J.-L. Canadian Wildlife Service, Sainte-Foy, PQ (Canada). 1989. 72p. (MICROLOG–89-04534). Available from PC Canadian Wildlife Service, 175 Woodward Dr., Ottawa, ON, CAN K1A 0E7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

The first part of this study examines the potential impact of acid precipitation on lacustrine birds in Quebec. The composition of bird communities at lakes in regions with various levels of acid deposition and sensitivity was studied and the relative importance of environmental features in the selection of wetland habitats by birds was assessed. It was observed that lakes in the temperate zone supported a dozen lacustrine species whether they were acidic or not, whereas acidic lakes in the taiga had only half as many species as neutral or alkaline lakes. At acidic lakes, it is primarily the aquatic species that are missing. The statistical technique of correspondence analysis showed that productivity, as estimated by chlorophyll levels, and the nature of the interface between riparian vegetation and water were the two most important factors in the division of available habitats among aquatic species. Water color is also an important factor. A similar variety of riparian species was found regardless of the degree of soil mineralization and acidity. The second part of this study describes the lake habitats, and the potential effects of acidification on these habitats. The aquatic and riparian vegetation of 78 lakes in southern Quebec and 68 lakes in northern Quebec are described and related to the regional characteristics of the environments in which they occur, the morphometry and water quality of the lakes, and features of the riparian soils. At the southern lakes, 9 associations of aquatic plants are described, and 5 associations at the northern lakes. For riparian vegetation, 11 associations were identified, belonging to 6 morphological units in the southern lakes and 10 units in the northern ones. 123 refs., 15 figs., 24 tabs.

31592 (CWS/SF–67F) **Studies of the effect of acidification on aquatic wildlife in Canada: Lacustrine birds and their habitats in Quebec.** DesGranges, J.-L. Canadian Wildlife Service, Sainte-Foy, PQ (Canada). 1989. 75p. (MICROLOG–89-04535). Available from PC Canadian Wildlife Service, 175 Woodward Dr., Ottawa, ON, CAN K1A 0E7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

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31593 (DOE/ER/60592–5) **[Particle deposition in human and canine tracheobronchial casts]: Progress report.** New York Univ., NY (USA). Medical Center. [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER60592. Order Number DE90009738. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To predict deposition efficiency, knowledge is required of airway morphometry and the distributions of inhaled airflow. The latter are expected to vary with flow rate and detailed measurements are needed to quantitate this parameter in the human and dog models. These data should provide essential input for the development of modifying factors in incorporate flow dependent, non-homogeneous mass transfer needed for quantitative dosimetry. Full morphometric and inhalation flow distribution measurements on the human and canine airway casts were completed in the current grant period. The work provided new quantitative data of airflow distribution in a realistic central airway cast for two species and for two different airflow patterns; steady inspiratory flow and pulsatile inspiratory flow. The work is summarized in this paper. Ten cast deposition experiments have been completed to date.

31594 (FO/CAR–89-04814) **Ten years of data for four cyprinid species in Lake 114, an experimentally acidified lake in the experimental lakes area, northwestern Ontario.** Canadian data report of fisheries and aquatic sciences, no. 733. Chalanchuk, S.M.; Mohr, L.C.; Allan, D.J. Department of Fisheries and Oceans, Winnipeg, MB (Canada). Central and Arctic Region. May 1989. 29p. (MICROLOG–89-04814). Available from PC Canada Dept. of Fisheries and Oceans, Scientific Publications, 200 Kent St., 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

Data are presented on length-frequency distributions and catch compositions for 4 Cyprinidae species in the experimental lakes area (ELA) in northwestern Ontario. The 4 species studied are the

most abundant and widespread species in the ELA, are distributed throughout a large part of North America, and are a significant food source for many larger fish. At one lake, 33.6 liters of electrolyte grade sulfuric acid were added at monthly intervals over a 7-year period to simulate precipitation events at a pH one unit lower than the natural pH of rain on the lake. This provided an opportunity to monitor the population dynamics of the fish in response to acid pulses rather than to relatively constant acid inputs. Maximum fork lengths attained by each species were 133 mm by pearl dace (Semotilus margarita), 89 mm by fathead minnow (Pimephales promelas), 85 mm by northern redbelly dace (Phoxinus eos), and 97 mm by finescale dace (Phoxinus neogaeus). These lengths are compared to those of other North American populations. 23 refs., 6 figs., 1 tab.

31595 (GKSS–88/E/55) **The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.** Bauch, J. (Hamburg Univ. (Germany, F.R.). Ordinariat fuer Holzbiologie); Michaelis, W. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. 382p. (In German). Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

At the site 'Postturm', forest district Farchau/Ratzeburg, an interdisciplinary research programme on 'forest decline and air pollution' is carried through. Three field stations have been set up to measure inorganic and organic pollutants and to perform physiological experiments in the tree-tops. Biological and chemical studies on needles, wood and fine roots of old growth spruce as well as soil-chemical analyses serve to examine how far relationships between environmental pollution and impacts on the trees exist. Moreover, the wood properties of physiologically affected spruce are to be determined and population-genetical aspects will be considered. Separate abstracts were prepared for 22 papers in this report. (orig./KG).

31596 (GKSS–88/E/55, pp. 81-98) **Biomonitoring for assessing air pollution: Heavy metal contents in the feathers of magpie (Pica pica L.) and goshawk (Accipiter gentilis L.) in Hamburg.** Ellenberg, H. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Hamburg (Germany, F.R.). Inst. fuer Weltforstwirtschaft und Oekologie); Kuehnast, O. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Concentration of heavy metals appears to be high in bird feathers compared to many other environmental materials. Strong correlations ($r > 0,9$) between deposition rates measured by wet deposition samplers and contents of a few or even single feathers collected in the vicinity of the deposition samplers have in earlier publications been demonstrated for lead and cadmium with magpie and goshawk feathers (Ellenberg et al., 1985). By their daily activities in their home ranges these sedentary birds 'integrate' temporally and above all spatially the heavy metal pollution of their territories. This is why it is possible to calculate deposition rates from measured feather contents. Some few deposition samplers are sufficient now for 'calibration' of those feather contents. By this means large areas may be covered with sufficiently precise investigations of heavy metal deposition rates. - Feather contents of Pb and Cd in the vicinity of the 'Postturm' have been shown to be coincident within narrow ranges with independently measured 'exact' data (Michaelis et al., this volume) of deposition rates of these metals, there. (orig.).

31597 (GKSS–88/E/55, pp. 101-119) **Process of adsorptive and absorptive enrichment of airborne organic compounds in spruce needles.** Figge, K. (Natec-Gesellschaft fuer Naturwissenschaftlich-Technische Dienste mbH, Hamburg (Germany, F.R.)). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7400-5. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

In the course of elucidating the ad-/absorptive enrichment of airborne organic substances in foliages, tetrachloroethylene (TCE) was considered as the first test substance. The TCE is found to an increasing extent in the atmosphere. The partition coefficient for TCE in the contact system 'leaf cuticle/air' is large. The partition equilibrium in the contact system 'spruce needles/air' is achieved rapidly, i.e. practically within 1 hour. The process of desorption of TCE from spruce twigs into TCE-free air can be divided into two parallel partial processes of 1st order with differing rates, namely the desorption from needles and that from the remaining parts of the twigs. The rate constant for TCE desorption in the case of the needles is approximately 10-fold smaller than in the case of the remaining parts of the spruce twigs. (orig./KG).

31598 (GKSS–88/E/55, pp. 121-130) **Ultrastructural changes in needles of damaged spruces at the 'Postturm' site.** Meyberg, M. (Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik); Lockhausen, J.; Schult, B.; Kristen, U. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7401-6. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Ultrastructural changes in the mesophyll of young and senescent spruce needles were electron microscopically examined using healthy and diseased trees of the spruce site 'Postturm' (forest district Farchau/Ratzeburg, FRG). The chloroplasts in five and six years old needles from a healthy tree exhibited a large numerical increase of plastoglobules and a reduction of the thylakoides. They finally entered the stage of typical gerontoplasts. In the chloroplasts of two years old needles from a diseased tree the thylakoides were strongly dilated. These dilatations caused the spherical shape of the chloroplasts. From all these findings it is suggested that structural changes either related to senescence or caused by disease are clearly distinguishable from each other on the cellular level. (orig./KG).

31599 (GKSS–88/E/55, pp. 131-137) **Investigations on cytotoxicity of airborne organic compounds at the 'Postturm' site.** Meyberg, M. (Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik); Kappler, R.; Kristen, U. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7401-6. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

To date, 150 organic compounds have been found in the atmosphere of the spruce site 'Postturm' (forest district Farchau/Ratzeburg, FRG). In order to identify the potentially cytotoxic substances among this large number, a screening technique has been employed which is based on the inhibition of pollen tube growth by such substances. The procedure involves photometric quantification of the pollen tubes produced in vitro. Eight compounds have been shown to be potentially cytotoxic. For 2-tert-butyl-4-methoxyphenol and 2,4-dinitrophenol, the ED_{50}-value (mean effective dose) was even below 2 mg l^{-1}. (orig./KG).

31600 (GKSS–88/E/55, pp. 139-149) **Application of semithin sections in the histochemical analysis of needles.** Meyberg, M. (Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik); Kristen, U. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7401-6. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Needle tissue of Pinus and Picea, fixed with glutaraldehyde/osmium tetroxide, were embedded in epoxy resin. Semithin sections of this material were treated with PAS, Coomassie brilliant blue and Sudan black. The PAS fluorescence method for the localization of polysaccharides proved to be well suited for demonstrating the specific structures of the different tissue types and the distribution of starch grains. It was shown, that the Strasburger cells, the cells of the bundle sheath and the parenchyma cells of the transfusion tissue were rich in proteins. The same cell types, in

addition to parenchyma cells of the xylem and phloem and to mesophyll cells contained lipids or lipophilic material. The results clearly demonstrate that the semithin sections can be well used for the biochemical localization of polysaccharides, proteins and lipids in the needle tissue. (orig./KG).

31601 (GKSS–88/E/55, pp. 151-171) **Test of physiological parameters for the judgement of spruce damage.** Naumann, R. (Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik und Botanischer Garten); Ludewig, M.; Fenner, R.; Lalk, I.; Bigdon, M.; Doerffling, K. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7404-9. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The diagnostic value of several physiological parameters for the evaluation of free damage in a ninety years old spruce stand near Ratzeburg (Northern Germany) has been studied. The physiological parameters studied were: level of abscisic acid (ABA) and proline in green, healthy-looking needles of trees with different degrees of damage, the qualitative and quantitative variation of free and bound amino acids, the activity of water soluble peroxidase, the emission of ethylene and the water status. The degree of tree damage was characterized according to the loss of needles. The results show that twigs from trees with strong symptoms of damage had lower values of water potential and turgor potential in comparison to trees with less severe symptoms. During the winter season these differences were less pronounced or even not observable. Green needles from trees with strong needle loss produced more ethylene and had higher levels of abscisic acid and proline than needles from undamaged trees. (orig./KG).

31602 (GKSS–88/E/55, pp. 173-185) **Investigations about day period of intercellular ethylene concentration in spruce sprouts.** Schulte-Baukloh, C. (Hamburg Univ. (Germany, F.R.). Inst. fuer Allgemeine Botanik und Botanischer Garten); Fenner, R.; Ludewig, M.; Naumann, R.; Lalk, I.; Bigdon, M.; Doerffling, K. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The present paper describes the application of a method to measure the intercellular concentration of ethylene in spruce twigs under field conditions. Moreover, data of daily changes of the internal concentration of ethylene and of the ethylene precursor 1-aminocyclopropane-1-carboxylic acid (ACC) in relation to climatic data and data of the water status are presented together with results of the ethylene emanation. Two spruce trees in a forest near Ratzeburg (Northern Germany) were used, differing in their degree of damage (forest dieback). Daily changes of the intercellular concentration of ethylene, but not of the ethylene emanation and the ACC-content were observable. Differences related to the degree of damage were observed only in the emanation of ethylene. (orig./KG).

31603 (GKSS–88/E/55, pp. 189-214) **Soil and root investigation on experimental plots of the 'Postturm' site, Farchau/Ratzeburg forest district.** Murach, D. (Goettingen Univ. (Germany, F.R.). Inst. fuer Waldbau); Rapp, C.; Ulrich, B. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

At two plots of the experimental forest 'Postturm', forest district Farchau/Ratzeburg, exhibiting a different extent of damage symptoms for spruce, soil and root investigations were carried out between 1984 and 1986. The soil chemical studies show an advanced acidification of the soil at both plots. The deeper soil layers have reached acidity levels of the Al, and the upper soil layers of the Fe buffer range. The extent of fine root development in mineral soil indicates a distinct vertical gradient. Soil physical growth parameters cannot give an explanation for this phenomenon on such a sandy site. Rather the gradient of fine root concentration goes along with the gradient of Ca/Al ratio in the soil solution and fine roots, and underline the importance of soil chemical parameters for the fine root distribution. (orig./KG).

31604 (GKSS–88/E/55, pp. 215-254) **Influence of the element concentration in the soil solution on element content in healthy and damaged spruces at the 'Postturm' site.** Rademacher, P. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Michaelis, W.; Bauch, J. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7454-0. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The concentration of nutrients and toxic elements in the soil solution of the upper layer and mineral soil as well as the element content in the fine roots, root xylem, stem wood and needles were investigated for the spruce site 'Postturm', forest district Farchau/Ratzeburg. In the upper layer and mineral soil the soil solution exhibits a considerable depression of available K, which results in an insufficient K-content in the spruce. The anomalous high content of Al in the fine roots of the mineral soil causes simultaneously a depression in the Ca-uptake. The high Pb-content in the upper soil obviously leads to a considerable amount of this element in the fine roots and needles. Furthermore, a low content of Mg was registered in the fine roots and the older needles. The partly considerable stress on the spruce via soil-chemical influences is demonstrated by the analyses performed. (orig./KG).

31605 (GKSS–88/E/55, pp. 255-286) **Investigations with microprobes in exchange and uptake of ions in mycorrhizae and sterile fine roots of spruce.** Kuhn, A.J. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Biologische Informationsverarbeitung); Schroeder, W.H.; Bauch, J.; Kottke, I.; Oberwinkler, F. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The described experiment were carried out in order to investigate on the cellular level ion exchange and ion uptake in fine roots and mycorrhizae of Picea abies (L.) Karst. For the investigation of ion concentrations in mycorrhizae and in sterile fine roots the Laser-Microprobe (LAMMA) was employed. This technique was combined with stable isotope labelling (using ^{25}Mg, ^{41}K, ^{44}Ca) of nutrient solutions, and with Energy-Dispersive-X-ray-Analysis (EDXA). The results confirm the significance of different soils for the distribution of the elements in fine roots and mycorrhizae. (orig./KG).

31606 (GKSS–88/E/55, pp. 289-304) **Growth rate reduction at the forest decline stand 'Postturm', Farchau/Ratzeburg forest district.** Bauch, J. (Hamburg Univ. (Germany, F.R.). Ordinariat fuer Holzbiologie); Goettsche-Kuehn, H.; Riehl, G. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

In November 1986 an area of 2.56 ha stocked with 204 90 to 120 year old spruce trees was clear cut following a previous assessment with regard to damage classes and sociological standing. Growth ring width, volume increment, sapwood area and fungal colonization were determined at all 204 trees. 30% were attributed to damage class < 1, ca. 56% to < 2, and 14% to < 3. An assessment of growth ring patterns of the individual damage classes and sociological classes shows a slight growth reduction only for the damage classes < 3. Predominant and codominant spruce trees of damage class ≥ 3 show serious growth depression. The total stand suffers from fungal infestation. The loss in volume and economic value caused by fungi is higher than that by growth depression due to pollution. (orig./KG).

31607 (GKSS–88/E/55, pp. 305-325) **Dendroecological preinvestigations on spruces at a forest decline area in northern Germany.** Eckstein, D. (Hamburg Univ. (Germany,

F.R.). Ordinariat fuer Holzbiologie). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Ten heavily damaged spruce trees in the Farchau/Ratzeburg forest district were dendroecologically analysed in order to enlighten the temporal development of damage. There is evidence for a disturbance having occurred in 1954 and for a contributing effect by the dry summer of 1976. Of the ten trees only five show a continuous growth depression during the last ten years. The growth determining climatic factor is the precipitation from April to July, whereas influence of temperature is nearly insignificant. Air pollution from the Hamburg industrial area and from the nearby eastern regions are considered being major stress factors. (orig./KG).

31608 (GKSS–88/E/55, pp. 327-336) **Seasonal changes in the content of soluble sugars, starch and extracts in the wood of healthy and damaged spruce (Picea abies (L.) Karst.).** Puls, J. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Hamburg (Germany, F.R.). Inst. fuer Holzchemie und Chemische Technologie des Holzes); Rademacher, P. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). Contract BMFT 03-7355-3. In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Changes in the concentration of the soluble sugars glucose, fructose and sucrose, starch and aromatic extractives during a year have been studied using increment cores from trunks of spruce (Picea abies (L.) Karst). During the winter from January to March higher concentrations of soluble sugars were measured in the cambium-near wood tissues of diseased trees. During the period of high starch concentrations in the parenchyma cells in October actual starch levels were higher in diseased trees. The same tendency reveals for the sugar concentration in October. However, during the time of the main vegetation period from May to October a worse supply with sugars, starch and its biosynthesis product coniferin was monitored. (orig./KG).

31609 (GKSS–88/E/55, pp. 337-348) **Technological properties of beech trees and oaks at the forest decline area 'Postturm', Farchau/Ratzeburg forest district.** Fruehwald, A. (Hamburg Univ. (Germany, F.R.). Ordinariat fuer Holztechnologie); Schwab, E. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Ten beach and six oak trees of different stage of disease were selected at the stand 'Postturm' to test elastomechanical, biological and chemical wood properties. Wood density is not reduced by the tree disease, which corresponds with the unchanged width of growth rings and distribution of cell types. MOE and strength properties remain unaffected but swelling and shrinkage factors in radial direction are increased in heavily damaged beech trees compared with healthy ones. (orig./KG).

31610 (GKSS–88/E/55, pp. 349-363) **Quality development in wet and dry storage of conifer stems of forest decline areas.** Fruehwald, A. (Hamburg Univ. (Germany, F.R.). Ordinariat fuer Holztechnologie). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Research projects dealt with the storage in a forest log yard, in a log pond and under sprinkling water of logs from healthy and diseased spruce and pine trees. The deficit in water content in the logs, caused by reduced sapwood width and reduced moisture content in the sapwood, is still to be determined after all of the storage tests. After a 4 months dry storage period, the sapwood of damaged spruce trees was discolored more intensively. Other wood properties remained unaffected. No differences occurred between wood from healthy and diseased spruce and pine trees when keeping the logs wet. However, some mechanical wood properties are generally reduced after storage under sprinkling water for 2.5 years. (orig./KG).

31611 (GKSS–88/E/55, pp. 367-369) **Importance of investigations about population genetics in forest decline areas.** Scholz, F. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Grosshansdorf (Germany, F.R.). Inst. fuer Forstgenetik und Forstpflanzenzuechtung). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The importance of research in genetical properties of tree populations in forest decline areas is discussed very briefly and leads to the investigations which are described in the following papers of this volume. (KG).

31612 (GKSS–88/E/55, pp. 371-382) **Investigations in genotype-environment interactions of spruce clones at different stands and under fumigation.** Scholz, F. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Grosshansdorf (Germany, F.R.). Inst. fuer Forstgenetik und Forstpflanzenzuechtung); Venne, H. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Ecologic-genetical investigations on clonal material from different single tree progenies and provenances show that the variation is governed by genetic factors to a great extent. If, however, such investigations are carried out with genetically identical material by using clones, genetic effects and interactions between genotypes and environment can be estimated. The cultivation of the Norway spruce clone material which was tested in fumigation experiments and characterized by isozymes as gene markers at the site 'Postturm' renders comparison of genotypes and estimation of genotype effects, comparisons to sites in which the material is also cultivated, investigations of genotype-environment-interactions as well as description of patterns of variation of response distributions between genotypes and sites. (orig./KG).

31613 (GKSS–88/E/55, pp. 383-387) **Experiments with populations of forest trees for viability selection.** Geburek, T. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Grosshansdorf (Germany, F.R.). Inst. fuer Forstgenetik und Forstpflanzenzuechtung); Scholz, F. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

The importance of heterozygosity for viability has been studied only initially. Field trials with spruce and birch have been planned, to test the hypothesis that high heterozygosity will improve viability under heterogeneous environmental conditions. (orig./KG).

31614 (GKSS–88/E/55, pp. 389-395) **Population genetical investigations in old trees and their descendants at sites influenced by air pollutants.** Venne, H. (Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Grosshansdorf (Germany, F.R.). Inst. fuer Forstgenetik und Forstpflanzenzuechtung); Scholz, F.; Geburek, T.; Bergmann, F. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1988. (In German). In *The research program forest decline at the site 'Postturm', forest district Farchau/Ratzeburg.* Order Number DE90784862. Available from NTIS (US Sales Only), PC A17/MF A01.

Recent results of laboratory experiments let assume that essential components of the reproductive processes can be affected by air pollutants and genotypic differences in sensitivity can cause narrowing of genetic multiplicity. On this hypothesis, population genetical investigations are planned in polluted Norway spruce or Scots pine stands. (orig./KG).

31615 (LIS–80) **Experimental studies by LIS for the purpose of investigating the possible causes of the recent forest**

decline. Krause, G.H.M.; Prinz, B. Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.). 1989. 217p. (In German). Order Number DE90785003. Available from NTIS (US Sales Only), PC A10/MF A01.

Several fumigation experiments under field and laboratory conditions with coniferous as well as deciduous plants were carried out. Deciduous trees turned out to be more sensitive than conifers and the following row of sensitivity based on visible injury was derived: Fagus sylvatica > Quercus robur > Acer platanoides > Pinus nigra > Pinus strobus > Picea abies > Abies alba. Ozone concentrations of 150-200 $\mu g\ m^{-3}$ lead to visible injury, a reduction in chlorophyll content and photosynthetic activity in beech and acer after 20 days of continuous fumigation. Similar effects were observed in Norway spruce only when concentrations exceeded markedly 200 $\mu g\ m^{-3}$. There is indication that ozone stimulates magnesium content and increases nitrate content of needles. No major growth effects were observed. Ozone effects on all species were increased under a regime of high light intensity, relative humidity and low nutrient content of soil. Low soil water conditions enhanced effects further. Combined application of ozone and acidic fog/rain increased cation leaching such as of magnesium, calcium and manganese from needles of Norway spruce. Leaching rate was increased with ozone concentration, H^+-ion concentration of fog, time sequence of ozone and fog episodes, low vitality of trees as well as low soil nutrient content. Results from these experiments allow to draw the resumee that of all gaseous air pollutants, ozone is far the most important one and can cause adverse effects in concentrations measured in areas with novel forest decline directly or indirectly by increased leaching due to acidic deposition and thus has still to be considered as a major causative agent. (orig./MG).

31616 (PB–90-153826/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony to DOL (Department of Labor) on identification, classification, and regulation of toxic substances posing a potential occupational carcinogenic risk by: Edward J. Baier, June 1978.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Jun 1978. 46p. Available from NTIS, PC A03/MF A01.

The testimony concerned proposed rulemaking by the Department of Labor Occupational Safety and Health Administration (OSHA) in relation to regulating exposures to potential carcinogenic substances encountered in the work place. The National Institute for Occupational Safety and Health (NIOSH) shared OSHA's concern with regard to the development of new procedures for the regulation of occupational carcinogens. The areas of the proposal addressed in the testimony included terminology, classification of chemicals, collection and evaluation of data, determination of exposure limits, and model standards. Under terminology, NIOSH took exception to the use of the term toxic substance and its equation with the term carcinogen since carcinogens are only a subset of toxic substances. The definition of potential occupational carcinogens as included in the proposal was deemed acceptable. The steps by which chemicals were classified into the categories of carcinogens were reviewed. While OSHA called for an alphabetical listing of the large group of potential carcinogens, NIOSH suggested that a preferable alternative would be to set priorities for evaluation of the substance based on an estimate of the degree of potential occupational hazard. Concern was also expressed regarding the adequacy and soundness of animal and human data. A series of questions from OSHA was attached along with the respective responses from NIOSH.

31617 (PB–90-170895/XAB) **Toxicology and carcinogenesis studies of hexachloroethane (CAS No. 67-72-1) in F344/N rats (gavage studies). Technical report.** Eastin, W.C. National Toxicology Program, Research Triangle Park, NC (USA). Aug 1989. 117p. (NTP-TR–361). Available from NTIS, PC A06/MF A01.

Also available from Supt. of Docs.

Toxicology and carcinogenesis studies were conducted by administering doses of 0, 10, or 20 mg/kg hexachloroethane in corn oil by gavage 5 days per week for 103 weeks to groups of 50 male rats. Groups of 50 female rats were administered 0, 80, or 160 mg/kg on the same schedule. Under the conditions of these 2-year gavage studies, there was clear evidence of carcinogenic activity of hexachloroethane for male F344/N rats, based on the increased incidences of renal neoplasms. The marginally increased incidences of pheochromocytomas of the adrenal gland may have been related to hexachloroethane administration to male rats. There was no evidence of carcinogenic activity of hexachloroethane for female F344/N rats administered 80 or 160 mg/kg by gavage for 103 weeks.

31618 (PB–90-171406/XAB) **Toxicological profile for alpha-, beta-, gamma- and delta- hexachlorocyclohexane. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 145p. Available from NTIS, PC A07/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for hexachlorocyclohexane is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31619 (PB–90-171414/XAB) **Toxicological profile for zinc. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 133p. Available from NTIS, PC A07/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for zinc is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31620 (PB–90-171422/XAB) **Toxicological profile for 1,2-dichloroethane. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 141p. Available from NTIS, PC A07/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for 1,2-dichloroethane is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31621 (PB–90-171430/XAB) **Toxicological profile for 2,4-dinitrotoluene and 2,6-dinitrotoluene. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 123p. Available from NTIS, PC A06/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for 2,4- and 2,6-dinitrotoluene is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31622 (PB–90-171455/XAB) **Toxicological profile for 3,3'-dichlorobenzidine. Final report.** Clement Associates, Inc., Fairfax, VA (USA). Dec 1989. 96p. Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

The ATSDR Toxicological Profile for 3,3-dichlorobenzidine is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31623 (PB–90-173170/XAB) **Studies on heavy trace-metal distribution in local fish and relevant waters. Doctoral thesis.** Ashraf, M. Quaid-i-Azam Univ., Islamabad (Pakistan). Dept. of Chemistry. 1990. 232p. Available from NTIS, PC A11/MF A02.

Sixteen marine, fifteen creek and thirty-four freshwater commercial fish species, together with relevant waters, were analyzed for ten essential/non-essential heavy trace metals by flame/flameless atomic absorption technique. The metals included Ni, Cu, Mn, Hg, Fe, Cr, Cd, Pb, As and Zn. In order to look into a probable local pollution effect, the levels of trace metals in various marine and creek fish, harvested from the coastal waters of the Arabian Sea, along the Karachi shore, were analyzed as to their trace-metal content. The freshwater fish, obtained from local lakes, streams and hatchery ponds in the provinces of Punjab, NWFP and Sind, were analyzed along with relevant waters to establish possible correlations between the heavy metal concentrations in fish muscle and in relevant waters. The macronutrient study was confined to twelve marine and seventeen freshwater fish species for the estimation of Ca, Na, K, and Mg in the edible muscle only.

31624 (PB–90-174855/XAB) **SARA (Superfund Amendments and Reauthorization Act) Section 313 Roadmaps data base. User's manual. Version 2.10. Final report.** ICF, Inc., Fairfax, VA (USA). 14 Jul 1989. 87p. Available from NTIS, PC A05/MF A01.

For system on diskettes, see PB–90-501487. See also PB–90-501479.

EPA has developed a database of sources of information on the chemicals listed in section 313 of the Superfund Amendments and Reauthorization Act (SARA). The database is intended to assist users of section 313 Toxic Release Inventory data to perform exposure and risk assessments of these chemicals. The Roadmaps system displays and/or prints information for the SARA section 313 chemicals on health and environmental effects, Federal regulation, and state air and water regulations, monitoring data, and state contacts.

31625 (PB–90-180191/XAB) **National Occupational Health Survey of mining: Mercury report.** National Inst. for Occupational Safety and Health, Morgantown, WV (USA). Div. of Respiratory Disease Studies. 24 Dec 1986. 24p. Available from NTIS, PC A03/MF A01.

The report presented data collected by the National Occupational Health Survey of Mining for the mercury commodity. One mine was surveyed for the data collection. Four chemicals were found on the mine property for which the Mine Safety and Health Administration (MSHA) has published exposure regulations. Three chemicals were found which have no NIOSH recommendations or MSHA exposure limits set. Forty-two trade named products were identified to which the workers were potentially exposed. Potential exposures to noise were also noted. Working conditions suggested musculoskeletal problems could develop involving the forearm/arm/shoulder, finger/hand, and wrist. Two welding processes were noted, arc welding and oxyfuel gas cutting. Estimated annual usage data was provided for chemical substances, both generic and tradenames.

31626 (PB–90-180324/XAB) **Review of literature on herbicides, including phenoxy herbicides and associated dioxins. Volume 13: Analysis of recent literature on health effects and Volume 14: Annotated bibliography of recent literature on health effects.** Clement Associates, Inc., Fairfax, VA (USA). 15 Jun 1989. 223p. Available from NTIS, PC A10/MF A02.

Also available from Supt. of Docs.

The report consists of a bibliography and critical review of scientific literature that became available during 1988 on the health effects of the herbicides (including impurities) used as defoliants in the Vietnam conflict. An attempt has been made to identify all scientific literature (including unpublished reports) relevant to the potential human health effects of the herbicidal preparation commonly referred to as Agent Orange, the herbicidal active ingredients 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichloroacetic acid and their esters, as well as polychlorinated dibenzo-p-dioxin, henceforth referred to as TCDD, known to be contaminating impurities of some phenoxy herbicide preparations, an the herbicides, picloram and cacodylic acid. The scope of the review does not include literature dealing exclusively with the chemistry, analysis, or environmental fate and effects of these compounds.

31627 (PB–90-180605/XAB) **Criteria for a recommended standard: Occupational exposure to carbon monoxide.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1972. 114p. (HSM–73-11000). Available from NTIS, PC A06/MF A01.

Also available from Supt. of Docs.

The report provides relevant data concerning the exposure of humans to carbon monoxide within the workplace. Recommendations for a carbon monoxide standard are provided based on analysis of data. The document covers the workplace environment (Air), medical, labelling, respiratory protection, emergency procedures, communication to employees of the hazards of carbon monoxide, work practices, and monitoring and record-keeping requirements.

31628 (PB–90-182114/XAB) **Toxicological profile for 1,1-dichloroethene. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 138p. Available from NTIS, PC A07/MF A01.

The ATSDR Toxicological Profile for 1,1-Dichloroethene is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31629 (PB–90-182122/XAB) **Toxicological profile for 1,2-dichloropropane. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 129p. Available from NTIS, PC A07/MF A01.

The ATSDR Toxicological Profile for 1,2-Dichloropropane is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31630 (PB–90-182130/XAB) **Toxicological profile for n-nitrosodimethylamine. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 129p. Available from NTIS, PC A07/MF A01.

The ATSDR Toxicological Profile for N-nitrosodimethylamine is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31631 (PB–90-182148/XAB) **Toxicological profile for 1,1,2,2-tetrachloroethane. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 96p. Available from NTIS, PC A05/MF A01.

The ATSDR Toxicological Profile for 1,1,2,2-Tetrachloroethane is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort.

31632 (PB–90-182155/XAB) **Toxicological profile for selenium. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 194p. Available from NTIS, PC A09/MF A02.

The ATSDR Toxicological Profile for Selenium is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31633 (PB–90-182163/XAB) **Toxicological profile for pentachlorophenol. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 146p. Available from NTIS, PC A07/MF A01.

The ATSDR Toxicological Profile for Pentachlorophenol is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31634 (PB–90-182171/XAB) **Toxicological profile for p,p'-DDT, p,p'-DDE, and p,p'-DDD. Final report.** Clement Associates, Inc., Washington, DC (USA). Dec 1989. 149p. Available from NTIS, PC A07/MF A01.

The ATSDR Toxicological Profile for p,p'-DDT,DDE,DDD is intended to characterize succinctly the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. Other literature is presented but described in less detail. The profile is not intended to be an exhaustive document; however, more comprehensive sources of specialty information are referenced. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. Research gaps in nontoxic and health effects information are described. Research gaps that are of significance to the protection of public health will be identified in a separate effort. The focus of the document is on health and toxicological information.

31635 (PB–90-861675/XAB) **Pentachlorophenol toxicity. August 1970-February 1990 (a Bibliography from the NTIS data base). Report for August 1970-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 58p. Available from NTISPC N01/MF N01.

Supersedes PB–87-863528.

This bibliography contains citations concerning toxicology studies of pentachlorophenol (PCP) and its effects on humans, and aquatic and laboratory animals. Topics include PCP determination and analysis methods, water quality criteria, and health risk assessments of PCP pesticides and insecticides. Human exposure in the workplace and hazard assessment, and techniques of PCP degradation and destruction are also discussed. Reports by EPA on PCP wood preservatives are also included. (This updated bibliography contains 90 citations, 29 of which are new entries to the previous edition.)

31636 **Effects of atmospheric pollutants on forests.** Hutchinson, T.C.; Meema, K.M. (eds.). 653p. Springer Verlag, New York, NY (US) (1987).

This book contains the proceedings of the NATO Advanced Workshop on the Effect of Acidic Deposition on Forest, Wetlands

and Agricultural Ecosystems, which was held in Toronto, Canada, in 1985. The workshop brought together approximately 40 scientists from Europe, the USA, and Canada, all involved in various aspects of air pollution research in natural and agro-ecosystems, and was divided into four working groups focusing on the potential impact of air pollution and atmospheric acid deposition on (i) forests, (ii) soils and soil microbial populations, (iii) agricultural crops, and (iv) wetlands and peatlands. The book provides a comprehensive summary of the state of the science in each of these main areas, identifies issues that warrant further research, and offers contrasting viewpoints as to the nature and/or causes of observed changes in ecosystem properties. It is further complemented with several papers on ecosystem stresses and plant physiological processes in light of their role as predisposing or exacerbating factors in pollution damage and ecosystem response, particularly in the context of the widely publicized forest decline phenomenon.

31637 A mutant of Arabidopsis thaliana that exhibits chlorosis in air but not in atmospheres enriched in CO_2. Artus, N.N. (Michigan State Univ., East Lansing (USA)); Somerville, C. *Plant Physiology (USA),* 87(1): 83-88 (May 1988).

A mutant of Arabidopsis thaliana (L.) Heynh. which requires a high concentration (2% by volume) of atmospheric CO_2 for growth has been isolated. Unlike previous mutants of this type, this line does not have any apparent defect in photosynthetic CO_2-fixation, photorespiration, or photosynthetic electron transport. The mutant is abnormally susceptible to pigment bleaching in air but not in 2% CO_2. The presence of normal or above-normal levels of antioxidants, carotenoids, and enzymes involved in reactive oxygen detoxification suggests that the mutant is equipped to detoxify activated oxygen species. Although it was not possible to establish a biochemical basis for the lesion, the properties of the mutant suggest the existence of a previously unidentified role for CO_2.

31638 Poly(γ-glutamylcysteinyl)glycine synthesis in Datura innoxia and binding with cadmium. Delhaize, E. (Los Alamos National Laboratory, NM (USA)); Jackson, P.J.; Lujan, L.D.; Robinson, N.J. *Plant Physiology (USA),* 89(2): 700-706 (Feb 1989).

The effects of Cd on poly(γ-glutamylcysteinyl)glycine [$(\gamma EC)_nG$] biosynthesis and formation of $(\gamma EC)_nG$:Cd complexes were measured in two cell lines of Datura innoxia with differing Cd tolerance. In addition, RNA synthesis, protein synthesis, and GSH concentrations were measured during 48 hour exposure to Cd. Exposure to 250 micromolar $CdCl_2$ was toxic to the sensitive line, whereas the tolerant line survived and grew in its presence. Cd-sensitive cells synthesized the same amount of $(\gamma EC)_nG$ as tolerant cells during an initial 24 hour exposure to 250 micromolar $CdCl_2$. However, rates of $(\gamma EC)_nG$:Cd complex formation differed between the two cell lines with the sensitive cells forming complexes later than tolerant cells. In addition, the complexes formed by sensitive cells were of lower molecular weight than those of tolerant cells and did not bind all of the cellular Cd. Pulse-labeling of cells with L-[^{35}S]cysteine resulted in equivalent rates of incorporation into the $(\gamma EC)_nG$ of both cell lines during the initial 24 hours after Cd. Rates of protein and RNA synthesis were similar for both cell lines during the initial 8 hours after Cd but thereafter declined rapidly in sensitive cells. This was reflected by a decline in viability of sensitive cells. The GSH content of both cell lines declined rapidly upon exposure to Cd but was higher in sensitive cells throughout the experiment. These results show that the biosynthetic pathway for $(\gamma EC)_nG$ synthesis in sensitive cells is operational and that relative overproduction of $(\gamma EC)_nG$ is not the mechanism of Cd-tolerance in a Cd-tolerant cell line of D. innoxia. Rapid formation of $(\gamma EC)_nG$:Cd complexes that bind all of the cellular Cd within 24 hours appears to correlate with tolerance in these cells.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 31625

31639 (AD-A-217065/2/XAB) **Long-term bioeffects of 435-MHz radiofrequency radiation on selected blood-borne endpoints in cannulated rats. Volume 2. Plasma ACTH (adrenocorticotropic hormone) and plasma corticosterone. Final report, 20 August 1984-16 February 1986.** Popovic, V.P.; Toler, J.C.; Bonasera, S.J.; Popovic, P.P.; Honeycutt, C.B. Georgia Inst. of Tech., Atlanta, GA (USA). Research Inst. Aug 1987. 98p. Available from NTIS, PC A05/MF A01.

See also Volume 3, AD-B183 863.

Two hundred adult male white rats with chronically implanted aortic cannulas were randomly divided into two groups. Animals in the first group were exposed to low-level (1.0 mW/cm2) pulsed-wave 435-MHz radiofrequency radiation (RFR) for approximately 22 h daily, 7 days each week, for 6 months. Animals in the second group were maintained under identical conditions, but were not radiated. The cannulas were used to draw microsamples (0.3 mL) of aortic blood from the unrestrained, unanesthetized rats on a cyclic schedule. Plasma adrenocorticotropic hormone (ACTH) and plasma corticosterone concentrations were determined by radioimmunoassays hormone (ACTH) and plasma corticosterone concentrations were determined by radioimmunoassays. Statistical analysis of the results did not indicate increased plasma ACTH and plasma corticosterone concentrations in exposed animals when compared to sham-exposed animals. Exposure to this low-level radiofrequency environment did not induce stresses that were manifested as an alteration in plasma hormones.

31640 (PB-90-861816/XAB) **Laser radiation: Biological effects. January 1978-February 1990 (a Bibliography from the NTIS data base). Report for January 1978-February 1990.** National Technical Information Service, Springfield, VA (USA). Mar 1990. 78p. Available from NTISPC N01/MF N01.

Supersedes PB-87-865085.

This bibliography contains citations concerning radiation injuries, permissible dosage, protective devices, and safety measures. Included are references regarding the pathology of eye lesions caused by lasers. (This updated bibliography contains 134 citations, 28 of which are new entries to the previous edition.)

57 HEALTH AND SAFETY

31641 (CONF-900351-3) **The development of initial isolation and protective action distances table for US DOT [Department of Transportation] publication, 1990 Emergency Response Guidebook.** Maloney, D.M. (Argonne National Lab., IL (USA)); Policastro, A.J.; Coke, L.; Dunn, W. Argonne National Lab., IL (USA). [1990]. 14p. Sponsored by U.S. Department of Transportation. DOE Contract W-31109-ENG-38. From 3. annual presentation: HazMat Central; Rosemont, IL (USA); 13-15 Mar 1990. Order Number DE90010085. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Department of Transportation's 1990 Emergency Response Guidebook will provide an updated Initial Isolation and Protective Action Distances Table guiding first responders during the first 30 minutes of a toxic chemical release from a transportation accident. This paper summarizes the methodology and models used to prepare that table and discusses the major technical issues that were faced in its development. The modeling carried out for the 1990 Table attempted to improve the physics of the source-term release and atmospheric dispersion. Realistic gaseous and liquid accident release scenarios were identified for each of 140 chemicals. The downwind impact was then computed for releases of each chemical from a variety of appropriate container sizes. Among the submodels used in the source-term and transport modeling were gaseous and liquid release models for the various sizes of containers, pool evaporation models, a flashing model, and an atmospheric dispersion model. A key issue for future study involves the use of the various toxicological guidelines that are presently available for the various chemicals, considering that no single exposure limit has been determined for all chemicals of interest for emergency response planning, and there is no uniform guidance by the toxicologists on the use of the various exposure guidelines in the presence of time-dependent exposures. 10 refs., 2 figs., 2 tabs.

31642 (EGG-EST-8946) **Hydrofluoric acid and anhydrous ammonia spills evaporation/air dispersion modeling and exposure assessment.** Abbott, M.L. EG and G Idaho, Inc., Idaho Falls,

ID (USA). Apr 1990. 158p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009806. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This report provides an assessment of the air dispersion and human exposure to toxic airborne chemical concentrations resulting from potential spill scenarios involving a volatile liquid–hydrofluoric acid (HF) and a liquified gas–anhydrous ammonia (NH3). The HF spill was evaluated both as a ground-level area source and a stack release from within a building. The NH3 spill was only evaluated as a ground-level area source. Critical receptors for exposure assessment were located downwind at 100 m, the nearest public highway, and the nearest site boundary. In addition, worker exposure inside a building after an indoor spill of HF was evaluated. The evaporation computer code SPILLS was used to determine time-variable emission (evaporation) rates for input into the air dispersion model INPUFF. First order kinetic models were used to evaluate the buildup and decay of the indoor HF spill using both steady state and SPILLS time-variable emission rates. Air concentrations were plotted as a function of time to determine the time intervals that receptor concentrations exceeded the TLV, IDLH, and 10,000*TLV levels. 7 refs., 12 figs., 5 tabs.

31643 (IAEA-HPRA–14) **Health physics research abstracts No.14: Information on research in progress.** International Atomic Energy Agency, Vienna (Austria). Jan 1989. 238p. Order Number DE90627130. Available from NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS.

The present issue No. 14 of Health Physics Research Abstracts is the continuation of a series of bulletins published by the Agency since 1967. They collect reports from Member States on Health Physics research in progress or just completed. The main aim in issuing such reports is to draw attention to work that is about to be published and to enable interested scientists to obtain further information through direct correspondence with the investigator. The present issue contains 381 reports received up to September 1988.

58 GEOSCIENCES

Refer also to citation(s) 30035, 30038, 30046, 30125, 30127, 30142, 30144, 30372, 30639, 30884

31644 (CONF-8203222–Summ.) **The lithosphere: Report of a workshop: [Summary].** National Research Council, Washington, DC (USA). U.S. Geodynamics Committee. 1983. 50p. Sponsored by U.S. DOE Energy Research; National Aeronautics and Space Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. From Workshop on the lithosphere; Austin, TX (USA); 15-19 Mar 1982. Order Number DE90010445. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document is the report of a week-long workshop on problems relating to the interpretations of the composition and dynamics of the lithosphere. A wide range of topics was discussed, dealing not only with the lithosphere itself, but also with possible interactions between the lithosphere and underlying mantle, down to and including the core-mantle boundary zone. Emphasis, very broadly, was on the physical and chemical properties of the lower crust and the subcrustal lithosphere: the physical and chemical characteristics of the prominent seismic discontinuities down to the core-mantle boundary; the nature and patterns of possible convection within the mantle and its relation to the generation, subduction, and intermixing of lithospheric and mantle material; the location and nature and evolution of reservoirs supplying magmas to the crust; and the various models that have been proposed to account for the location, nature, and geological history of these magma reservoirs. The general applicability of the plate tectonics model was assumed, but virtually every widely accepted explanation for the dynamics of that model and of possible unrelated phenomena such as deep-mantle plumes and hot spots was brought into question. 83 refs., 19 figs.

31645 (CONF-8602184–Summ.) **Summary of summit meeting of professional society presidents and/or executive directors.** National Research Council, Washington, DC (USA). Board on Earth Sciences. Apr 1986. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. From Board on Earth Sciences meeting; Washington, DC (USA); 7 Feb 1986. Order Number DE90010504. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Board on Earth Sciences convened a meeting of presidents and executive directors of major American solid earth sciences professional organizations on February 7, 1986, to explore the commonalities of goals and to enhance the effectiveness of individuals and organizations. The following items were discussed by leaders in the earth sciences: responsibilities of the Board on Earth Sciences and the American Geological Institute; new scientific initiatives in the solid earth sciences; the 1989 International Geological Congress; the International Geosphere-Biosphere Program; the International Decade of Hazard Reduction; the deteriorating situation in the American energy and mineral resources industries; the state of geological mapping in the United States; and funding for research in the solid earth sciences. Policy statements were developed on several of the above topics. Problem areas were identified that require the continuing attention of the earth sciences community. The problem areas enumerated during the meeting are presented in summary in the text. 3 figs.

31646 (CONF-8702184–Summ.) **Summary of summit meeting of professional society presidents and/or executive directors.** National Research Council, Washington, DC (USA). Board on Earth Sciences. Apr 1987. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. From 2. summit meeting of chief executives of solid-earth science organizations; Washington, DC (USA); 6 Feb 1987. Order Number DE90010503. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the second Summit Meeting of presidents and executive officers of earth sciences societies. The meeting was held on February 6, 1987, in Washington, D.C., under the aegis of the Board on Earth Sciences (BES), National Research Council (NRC). The purpose the meeting is to improve coordination among the solid-earth sciences so that they will be better able to serve national needs. In addition to meetings such as this, the Board provides briefings for decision makers, including congressmen and their staffs, on current issues of solid-earth sciences, such as seismic hazards, global geoscience initiatives, volcanic eruptions, and the like.

31647 (DOE/ER/12018–T1) **Seismographic networks: Problems and outlook for the 1980s.** National Research Council, Washington, DC (USA). Committee on Seismology. 1983. 62p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. Order Number DE90010442. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Seismographic networks collect the data fundamental to the science of seismology, providing recording of ground motion from natural earthquakes and other seismic sources ranging in size from the great earthquakes to the smallest detectable microearthquakes. This ground motion reveals. The seismographic networks are the basic scientific tools, that provide the continuing data base for the science. It is very important, to keep US-supported seismographic networks in the best operating condition, to provide networks with the latest technology, and to improve constantly the management and data bases of the networks. The importance of observational data from seismographic networks has not been recognized consistently by decision makers allocating funds among competing programs. The various governmental agencies responsible for network operations encounter many difficulties in obtaining adequate funding for the maintenance, upgrading, and the research associated with these important national facilities. This report is the result of a workshop convened at the request of several governmental agencies to review the status and associated problems of and the outlook for seismographic networks. Recommendations have been made to help solve the problems and to assure a viable observational capability for the future. 8 refs., 6 figs.

31648 (DOE/ER/12018–T5) **Geology and our future: Summary of a workshop report.** National Research Council, Washington, DC (USA). Geological Sciences Board. 1983. 28p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; U.S.

Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010447. Available from NTIS, PC A03/MF A01 - OSTI.

The purpose of this report is to highlight, for decision makers and other interested citizens, the significance of the geological sciences to our nation and to society. Discussions of the selected topics treated in these pages are based on a workshop held by the Geological Sciences Board in June 1981 to consider future intellectual challenges and social applications of the geological sciences. Participants included Board members and invited guests from industry, academia, and the government with expertise sufficiently broad to provide an overview and an outlook for the geological sciences. The perspectives of the discussions at the workshop were long, perhaps a few decades. 33 refs.

31649 (DOE/ER/12018–T7) **Probabilistic Seismic Hazard Analysis.** National Research Council, Washington, DC (USA). Committee on Seismology. 1988. 107p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Federal Emergency Management Agency; Nuclear Regulatory Commission; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010449. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The purpose of Probabilistic Seismic Hazard Analysis (PSHA) is to evaluate the hazard of seismic ground motion at a site by considering all possible earthquakes in the area, estimating the associated shaking at the site, and calculating the probabilities of these occurrences. The Panel on Seismic Hazard Analysis is charged with assessment of the capabilities, limitations, and future trends of PSHA in the context of alternatives. The report identifies and discusses key issues of PSHA and is addressed to decision makers with a modest scientific and technical background and to the scientific and technical community. 37 refs., 19 figs.

31650 (DOE/ER/12018–T9) **Explosive volcanism: inception, evolution, and hazards: Studies in geophysics.** National Research Council, Washington, DC (USA). Geophysics Study Committee. 1984. 176p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010451. Available from NTIS, PC A10/MF A01 - OSTI.

One purpose of the studies is to provide assessments from the scientific community to aid policymakers in decisions on societal problems that involve geophysics. An important part of such an assessment is an evaluation of the adequacy of present geophysical knowledge and the appropriateness of present research programs to provide information required for those decisions. Some of the studies place more emphasis on assessing the present status of a field of geophysics and identifying the most promising directions for future research. This study on explosive volcanism was begun soon after the cataclysmic eruptions of Mount St. Helens. It readily became apparent to the committee that an assessment of the explosive nature of volcanoes must cover all types of volcanic activity; any volcano can be explosive. Improved understanding of the physics of volcanic eruptions is an exciting goal that is vital to progress in hazard evaluation. The study of explosive volcanism must include an appreciation of the severe social problems that are caused by erupting volcanoes. None is of greater urgency than planning for a crisis. This report considers the progress in research on these aspects of explosive volcanism and the need for additional research efforts. This volume contains 13 papers. Topics include tectonism, volcanism, volcanic periodicity, eruptive mechanics, emergency planning and recommendations. Individual papers are indexed separately on the energy data base.

31651 (DOE/ER/12018–T10) **Active tectonics: Studies in geophysics.** National Research Council, Washington, DC (USA). Geophysics Study Committee. 1986. 266p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010452. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This study is part of a series of Studies in Geophysics that have been undertaken for the Geophysics Research Forum by the Geophysics Study Committee. One purpose of each study is to provide assessments from the scientific community to aid policymakers in decisions on societal problems that involve geophysics. An important part of such assessments is an evaluation of the adequacy of current geophysical knowledge and the appropriateness of current research programs as a source of information required for those decisions. The study addresses our current scientific understanding of active tectonics — particularly the patterns and rates of ongoing tectonic processes. Many of these processes cannot be described reasonably using the limited instrumental or historical records; however, most can be described adequately for practical purposes using the geologic record of the past 500,000 years. A program of fundamental research focusing especially on Quaternary tectonic geology and geomorphology, paleoseismology, neotectonics, and geodesy is recommended to better understand ongoing, active tectonic processes. This volume contains 16 papers. Individual papers are indexed separately on the Energy Database.

31652 (DOE/ER/12018–T14) **A proposed initiative for capitalizing on the Parkfield, California, earthquake prediction.** National Research Council, Washington, DC (USA). Board on Earth Sciences. 1986. 27p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; Nuclear Regulatory Commission; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010506. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In June 1985 a committee of the Board on Earth Sciences asked the National Research Council/National Academy of Sciences to bring to the attention of officials of the federal government the scientifically endorsed recent prediction of a moderate earthquake at Parkfield, California, between 1986 and 1993. This prediction offers a unique opportunity to improve our understanding of earthquakes and our future ability to predict them. An augmented experimental program at Parkfield is needed to document this high- probability event more completely, including the detection of premonitory phenomena. This report contains the information that was presented to the governmental officials. It is intended to stimulate their interest, understanding, and enthusiasm for augmenting an experimental program. If successful, the Parkfield experiment will eventually translate into decreasing the vulnerability of people to earthquake hazards. 9 refs., 4 figs.

31653 (DOE/ER/12018–T15) **Recommendations for the Strong-Motion Program in the United States.** National Research Council, Washington, DC (USA). Committee on Earthquake Engineering. 1987. 66p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG01-82ER12018. Order Number DE90010507. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The fundamental objective of the national Earthquake Hazard Reduction program is to develop economically and socially acceptable methods for minimizing damage caused by earthquakes. The design of safe and economical engineering structures requires an understanding of the nature of earthquake ground motion and the response of the structures to it. Previously recorded strong-motion data have greatly enhanced knowledge about the fault rupture process, the transmission of seismic wave energy from source to site, and the dynamics of structures, although the data base is far from comprehensive. There is a need not only for more data but also for more sophisticated types of data and analysis. Data management and distribution are becoming increasingly important as the number of strong-motion instruments and organizations that deploy them keeps growing. The totality of those involved in obtaining strong-motion records, processing, archiving, disseminating, and using strong-motion data is called, for purposes of this report, the US strong-motion program. this report discusses the program. 22 refs., 15 figs.

31654 (DOE/ER/12018–T16) **Priorities for a national program of continental drilling for scientific purposes.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1984. 13p. Sponsored by U.S. Department of

Defense; U.S. DOE Energy Research; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018;FG01-80ER10670. Order Number DE90010508. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The two reports, Continental Drilling and Continental Scientific Drilling Program, form a basis for this report and provide comprehensive discussions of the subject of continental drilling for scientific purposes in a number of research areas. The purpose of this report is to present a specific recommendation of the Continental Scientific Drilling Committee on where the first deep hole dedicated to scientific exploration of the continental crust in the United States should be located. The most accessible and feasible hypothesis to test is the one of thin-skinned tectonics; the southern Appalachians, where the thrusting of crystalline rocks of the Blue Ridge and Piedmont Provinces over early Paleozoic sedimentary rocks is postulated, represents the best location for this drilling project. This hypothesis is of fundamental importance to the understanding of the evolution of continents. 4 refs.

31655 (DOE/ER/12018–T17) **A national drilling program to study the roots of active hydrothermal systems related to young magmatic intrusions.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1984. 43p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018;FG01-80ER10670. Order Number DE90010509. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The importance of studies of active hydrothermal-magma systems as part of a national continental scientific drilling program has been emphasized in numerous workshops and symposia. The present report, prepared by the Panel on Thermal Regimes of the Continental Scientific Drilling Committee, both reinforces and expands on earlier recommendations. The US Geodynamics Committee 1979 report of the Los Almos workshop, Continental Scientific Drilling Program, placed major emphasis on maximizing the scientific value of current and planned drilling by industry and government, supplementing these efforts with holes drilled solely for scientific purposes. Although the present report notes the importance of opportunities for scientific investigations that may be added on to current, mission-oriented drilling activities, the Panel on Thermal Regimes recognizes that such opportunities are limited and thus focused its study on holes dedicated to broad scientific objectives. 16 refs., 2 figs., 4 tabs.

31656 (DOE/ER/12018–T19) **Mineral resources: Research objectives for continental scientific drilling.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1984. 64p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018;FG01-80ER10670. Grant EAR-8014913;Grant EAR-8212967;Grant N00014-80-G-0062;Grant Order Number DE90010511. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The importance of a scientific drilling program to study mineralized hydrothermal systems has been emphasized in numerous workshops and symposia. To some degree the present report, prepared by the Panel on Mineral Resources of the Continental Scientific Drilling Committee, both reinforces and expands upon earlier recommendations. The report of the Los Alamos workshop, Continental Scientific Drilling Program, placed a major emphasis on maximizing the industry and government, supplementing these efforts with holes drilled solely for scientific purposes. Although the present report notes the importance of opportunities for scientific investigations added on to current, mission-oriented drilling activities, the Panel on Mineral Resources recognized that such opportunities are limited and thus focused on holes dedicated to broad scientific objectives. In the present report, the panel has developed a program that will provide answers to many scientific questions that have existed for almost 100 years concerning mineralized hydrothermal systems. The committee notes that research drilling may lead to results in addition to those anticipated, results that will provide new directions and ideas of equal or greater value that those basic ones originally posed. 58 refs.

31657 (DOE/ER/12018–T20) **Research objectives for continental scientific drilling studies of active fault zones.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1987. 36p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010512. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The importance of a scientific drilling program to study active fault zones and earthquakes has been emphasized in numerous workshops and symposia, including the 1978 Los Alamos, New Mexico, Workshops on Continental Drilling for Scientific Purposes and 1974 Workshops on Continental Drilling held art Ghost Ranch, New Mexico. This report, prepared by the Panel on Downhole Physical Property Measurements and Fault-Zone Drilling of the Continental Scientific Drilling Committee, both reinforces and expands upon earlier recommendations and provides examples of possible sites. In this report, we explain briefly the scientific rationale used tin selecting each of these sites, the specific objectives of each hole, and the types of measurements that should be made both in situ and on recovered rock and fluid samples. In a final section we discuss methods for long-term deployment of downhole instruments for ultraquiet seismic, strain, and fluid monitoring. Such observations will make it possible to study active tectonic processes directly and to monitor them over time. 24 refs., 8 figs.

31658 (DOE/ER/12018–T21) **The objectives for deep scientific drilling in Yellowstone National Park.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1987. 69p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010513. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The western area of the United Stated contains three young silicic calderas, all of which contain attractive targets for scientific drilling. Of the three, the Yellowstone caldera complex is the largest, has the most intense geothermal anomalies, and is the most seismically active. On the basis of scientific objectives alone. it is easily the first choice for investigating active hydrothermal processes. This report briefly reviews what is known about the geology of Yellowstone National Park and highlights unique information that could be acquired by research drilling only in Yellowstone. However, it is not the purpose of this report to recommend specific drill sites or to put forth a specific drilling proposal. 175 refs., 9 figs., 2 tabs.

31659 (DOE/ER/12018–T22) **The scientific value of coring the proposed southern Appalachian research drill hole.** National Research Council, Washington, DC (USA). Continental Scientific Drilling Committee. 1987. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. Order Number DE90010514. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

At an early stage of its activities, the Continental Scientific Drilling Committee considered suggestions and preliminary proposals outlining the scientific problems that could be attacked by drilling and the site best suited for the effort. High on the priority list–indeed, the Committee rated it as having the highest scientific priority of all the first proposals-was a deep hole in the southern Appalachians that would test the model of thin-skinned overthrusting. This model, first suggested by scientific reflection profiling by COCORP, had implications for mountain building in general and would be an integral component of the plate tectonic hypothesis. In preparing the report, the Task Force kept in view the value of coring in general, while considering the Appalachian hole as a specific instance. The Continental Scientific Drilling Committee endorses this report of the Task Force and its recommendations. 45 refs., 2 figs., 2 tabs.

31660 (DOE/ER/12018–T23) **Effective use of earthquake data.** National Research Council, Washington, DC (USA). Committee on Seismology. 1983. 63p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-82ER12018. Order Number DE90010515. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Seismic data from earthquakes, especially those recorded digitally, have been accumulating rapidly in recent years. At present, diverse type of high-quality data are being generated under a wide

range of programs supported by many agencies. It is clear that with the development of high dynamic range, broadband digital seismic systems, the distinction between strong-motion recording and sensitive high-gain seismic recording is disappearing. This means that earthquake engineers and seismologists soon can share a common seismic data base for their respective applications. Therefore, the discussion in this report should be taken to apply to all types of earthquake ground-motion data. In this report we deal only peripherally with questions of instrumentation for primary data collection (seismograph systems). To realize fully the potential scientific returns in seismology requires that high-quality data not only be gathered but also effectively disseminated to a wide user community concerned with both basic research and application of seismic data. This report is addressed primarily to the problems of data management in seismology because of shortcomings in the present data-handling and -distribution practices. 6 refs., 2 figs., 1 tab.

31661 (DOE/ER/12018–T24) **Seismological studies of the continental lithosphere.** National Research Council, Washington, DC (USA). Committee on Seismology. 1984. 144p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; Nuclear Regulatory Commission; National Science Foundation; U.S. Geological Survey. DOE Contract FG01-82ER12018. Order Number DE90010446. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The "lithosphere," as used here in the generally accepted sense, includes the crust of the earth and that part of its upper mantle that, together with the crust, constitute the moving tectonic plates. These are underlain by the more easily deformed "asthenosphere" at a depth on the order of 100 km. The seismic low-velocity zone (LVZ) in the mantle is usually identified with the asthenosphere. We are convinced that a better understanding of the continental lithosphere is vital to society, much of that understanding can only be gained by the application of modern seismological methods, and to accomplish these objectives the United States needs urgently to upgrade its seismological capability. Our aim in this report is to convey to the reader our convictions with the hope that they will be translated into action. We suggest specific studies that should be undertaken now and some actions that, if taken, should realize the full potential of seismological techniques. 110 refs., 35 figs., 1 tab.

31662 (LA-UR–90-1196) **Elemental relationships in rock varnish as seen with SEM/EDX [scanning electron microscopy/energy dispersive x-ray] elemental line profiling.** Raymond, R. Jr.; Reneau, S.L.; Harrington, C.D. Los Alamos National Lab., NM (USA). [1990]. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9005166–1: Conference on scanning microscopy, Bethesda, MD (USA), 5-10 May 1990). Order Number DE90010568. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The heterogeneous nature of rock varnish requires a thorough survey of elemental and mineralogic compositions before relating chemical variability of rock varnish to past geochemical environments. Elemental relationships in rock varnish can be examined using scanning electron microscopy (SEM) in conjunction with an elemental line profiling routine using semi-quantitative, energy dispersive x-ray (EDX) analysis. Results of SEM/EDX analysis suggest: variations in cation concentrations used in varnish cation ratio dating relate more specifically to variations in detritus within the varnish than to element mobility as defined by weathering indices; Mn concentration rather than Mn:Fe ratios may be a more appropriate indicator of paleoclimatic fluctuations; and the Mn-oxide phase existing in varnish is most likely a Ba-enriched phase rather than birnessite. Element line profiling offers great potential for gaining insights into geochemical processes affecting the deposition and diagenesis of rock varnish and for testing hypotheses relating to its chemical variability. 27 refs., 9 figs.

31663 (LA-UR–90-1197) **SEM [scanning electron microscopy] analysis of rock varnish chemistry for cation-ratio dating: An examination of electron beam penetration depths.** Reneau, S.L.; Raymond, R. Jr.; Harrington, C.D.; Hagan, R.C. Los Alamos National Lab., NM (USA). 2 Apr 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9005166–2: Conference on scanning microscopy, Bethesda, MD (USA), 5-10 May 1990). Order Number DE90010569. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Rock varnish is a microns-thick manganese- and iron-rich coating that forms on exposed rock surfaces in arid and semi-arid environments. Empirical correlations of the varnish cation ratio (K+Ca)/Ti with age have been used to estimate ages of geomorphic surfaces, with varnish chemistry generally acquired by either proton-induced x-ray emission (PIXE) analysis of natural varnish surfaces. Chemical analyses of rock varnish with SEM/EDX utilize a sequence of accelerating voltages to vary penetration depths into the sample. Using elemental x-ray maps of natural varnish surfaces with SEM/EDX, penetration into the substrate can be recognized at accelerating voltages where contamination with substrate is inferred from SEM/EDX chemical analyses. This demonstrates the ability of the SEM method to obtain varnish chemistry with minimal inclusion of substrate. Calculations of theoretical x-ray depth-distribution ($\phi(\rho z)$) curves in varnish indicate that at an accelerating voltage of 10 kV most of the emitted electrons are generated in the upper 0.5 micron of a sample. At a higher voltage of 30 kV most of the signal is still restricted to the upper 2 microns, representing a very small percentage of total varnish volume in many cases. The ability of the SEM method to obtain empirical correlations of the chemistry of the uppermost varnish with varnish age suggests that significant time-dependent changes in chemistry occur in the upper one- to two-microns of rock varnish. 11 refs., 5 figs., 2 tabs.

31664 (LA-UR–90-1198) **Barium concentration in rock varnish: Implications for calibrated rock varnish dating curves.** Harrington, C.D.; Reneau, S.L.; Raymond, R. Jr.; Krier, D. Los Alamos National Lab., NM (USA). [1990]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9005166–3: Conference on scanning microscopy, Bethesda, MD (USA), 5-10 May 1990). Order Number DE90010570. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Cation-ratio dating rock varnish is a recently developed technique for obtaining surface exposure ages of a wide variety of geomorphic surfaces. As originally proposed, the technique utilizes a ratio among minor cations [(K + Ca)/Ti] in rock varnish. Although this varnish cation ratio is related to the Ti concentration, it can also be affected by the presence of Ba that may be partially included in the analyzed concentration of Ti. During energy-dispersive spectroscopy (EDS), Ba L-alpha and L-beta peaks overlap with Ti K-alpha and K-beta peaks. We have compared the effect of Ba concentration on calculated varnish cation ratios using quantitative EDS with the scanning electron microscope (SEM), quantitative wavelength-dispersive spectroscopy (WDS) with a Cameca electron probe microanalyzer (EPM) and qualitative EDS with the SEM that does not decompose Ti and Ba lines. In this paper we document that, in fact, such separation of Ba from Ti is possible using both a quantitative (MICRO Q) and a semi-quantitative (SQ) Tracor Northern EDS analytical programs that decompose Ti and Ba lines. We also document that SEM EDS analyses may yield markedly similar results to wavelength dispersive spectrometer (WDS) analyses of the same varnish using an EPM. 6 refs., 6 figs., 2 tabs.

31665 (NUREG/CR–4753-Vol.3) **Canadian seismic agreement: Annual report, 1987–1988: Volume 3.** Wetmiller, R.J.; Lyons, J.A.; Shannon, W.E.; Munro, P.S.; Thomas, J.T.; Andrew, M.D.; Lamontagne, M.; Wong, C.; Anglin, F.M.; Plouffe, M. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Geological Survey of Canada, Ottawa, ON (Canada). Geophysics Div.; Canadian Commercial Corp., Ottawa, ON (Canada). Apr 1990. 40p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

During the period of this report, the contract resources were spent on operation and maintenance of the Eastern Canada Telemetred Network (ECTN), development of special purpose local network systems, servicing and maintenance of the strong-motion seismograph network in eastern Canada, operation of the Ottawa data lab and earthquake monitoring and reporting. Of special note in this period was the final completion of the Sudbury (SLTN) and Charlevoix (CLTN) local networks and the integration of their data processing and analysis requirements in the regular analysis stream for ECTN data. These networks now acquire high quality

digital data for detailed analysis of seismic activity and source properties from these two areas, thus effectively doubling the amount of seismic data being received by the Ottawa data lab. 37 refs., 17 figs., 2 tabs.

31666 (NUREG/CR–4753-Vol.4) **Canadian seismic agreement: Annual report, 1988–1989.** Wetmiller, R.J.; Lyons, J.A.; Shannon, W.E.; Munro, P.S.; Thomas, J.T.; Andrew, M.D.; Lamontagne, M.; Wong, C., Anglin, F.M.; Plouffe, M.; Lapointe, S.P. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Canadian Commercial Corp., Ottawa, ON (Canada); Geological Survey of Canada, Ottawa, ON (Canada). Geophysics Div. Apr 1990. 59p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This is the twenty-first progress report under the agreement entitled Canadian Seismic Agreement between the US Nuclear Regulatory Commission (NRC) and the Canadian Commercial Corporation. Activities undertaken by the Geophysics Division of the Geological Survey of Canada (GD/GSC) during the period from July 01, 1988 to June 30, 1989 and supported in part by the NRC agreement are described below under four headings; Eastern Canada Telemetred Network and local network developments, Datalab developments, strong motion network developments and earthquake activity. In this time period eastern Canada experienced its largest earthquake in over 50 years. This earthquake, which has been christened the Saguenay earthquake, has provided a wealth of new data pertinent to earthquake engineering studies in eastern North America and is the subject of many continuing studies, which are presently being carried out at GD and elsewhere. 41 refs., 21 figs., 7 tabs.

31667 (NUREG/CR–5258-Vol.2) **Georgia/Alabama regional seismographic network: Annual report, July 1986–June 1987.** Long, L.T. (Georgia Inst. of Tech., Atlanta, GA (USA). School of Geophysical Sciences). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Georgia Inst. of Tech., Atlanta, GA (USA). School of Geophysical Sciences. Apr 1990. 61p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO - OSTI.

The objective of this study is to contribute data and analyses conducive to the development of criteria for establishing earthquake hazard potential in the southeastern United States. The first task is to install and maintain the Georgia/Alabama seismic network. The seismic network consists of about 21 stations in Alabama, Georgia, and adjoining regions of southeastern Tennessee and South Carolina. The seismic net includes three three-component short period stations and operates completely on solar power. The second task is to monitor the seismic activity in southeastern Tennessee, northern Alabama, and Georgia. The data are to be used in appropriate topical studies. Five topical studies achieved notable conclusions or were completed during the reporting period of July 1986 to June 1987. The principal conclusions are summarized and presented in this paper. 11 refs., 26 figs., 3 tabs.

31668 (PB–90-171521/XAB) **Simplex-method-based algorithm for determining the source location of microseismic events. Report of investigations/1989.** Riefenberg, J.S. Bureau of Mines, Denver, CO (USA). Denver Research Center. 24 Feb 1989. 20p. (BUMINES-RI–9287). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs. Library of Congress catalog card No. 89-15879.

The U.S. Bureau of Mines conducts basic and applied research related to predicting, eliminating, and/or controlling rock bursts in underground hard-rock mines and coal bumps in underground coal mines. An important element in this research is the development of a reliable and efficient microseismic source location technique. This report presents the results of a Bureau study to develop and evaluate a new algorithm to locate microseismic events based on the Simplex method, a powerful linear programming technique. The technique was tested on both field data and simulated data. Microseismic-event source locations obtained with this new Simplex-based algorithm were shown to have less error than those locations obtained using a least squares method. It was concluded that the Simplex approach to source location of microseismic events can be used effectively in microseismic monitoring.

31669 (SKB-TR–89-04) **SKB WP-cave project. Radionuclide release from the near-field in a WP-cave repository.** Lindgren, M. (Kemakta Konsult AB, Stockholm (Sweden)); Skagius, K. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Apr 1989. 85p. Order Number DE90626602. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The release of radionuclides from the bentonite-sand barrier (near-field) in a WP-cave repository for high level radioactive waste has been studied. Calculations were made for two cases; a Low Flow Through Case and a High Flow Through Case. The difference between the two cases lies in the assumed hydraulic properties of the bentonite-sand barrier and the system inside the barrier. The effect on the nuclide release of solubility limitations, sorption capacity of the barriers, radiolytic fuel oxidation rate as well as the thickness of the bentonite-sand barrier, were also investigated for the Low Flow Through Case. (authors).

31670 (SKB-TR–89-17) **Field instrumentation for hydrofracturing stress measurements: Documentation of the 1000 m hydrofracturing unit at Luleaa University of Technology.** Bjarnason, Bjarni; Torikka, Arne. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Aug 1989. 30p. Order Number DE90626322. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A recently developed system for rock stress measurements by the hydraulic fracturing method is documented in detail. The new equipment is intended for measurement in vertical or nearvertical boreholes, down to a maximum depth of 1000 m. The minimum borehole, diameter required is 56 mm. Downhole instrumentation comprises a straddle packer assembly for borehole fracturing, equipment for determination of fracture orientations and a pressure transducer. The downhole tools are operated by means of a multihose system, containing high pressure hydraulic tubings, signal cable and carrying wire into one hose unit. The surface components of the equipment include a system for generation and control of water pressures up to approximately 75 MPa, an hydraulically operated drum for the multihose and a data acquisition system. All surface instrumentation is permanently mounted on a truck, which also serves as power source for the instrumentation. In addition to the description of instrumentation, the theoretical fundament and the testing procedures associated with the hydraulic fracturing method are briefly outlined.

31671 (STRIPA-TR–89-04) **Site characterization and validation - singe borehole hydraulic testing: Stage 1.** Holmes, David C. (British Geological Survey, Keyworth (UK). Fluid Processes Research Group). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Mar 1989. 73p. Order Number DE90626323. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report describes the procedures used in measuring distributions of hydraulic conductivity and head in five of the six 'boundary boreholes' which form part of the Site Characterisation and Validation (SCV) programme. A novel multipacker system, utilising total computer control and data analysis, has been used to measure the hydraulic parameter in test sections from 7 to 1 m. in length. Generalised equipment descriptions and detailed results are included in this report. The distribution of hydraulic conductivity has been correlated with measured fracture positions and orientations for each borehole. Values of hydraulic conductivity and hydraulic aperture have been assigned to each 'coated' fracture which has been logged as being capable of transporting groundwater. Distribution statistics have been calculated for various fracture 'sets'. These distributions form part of the input required for fracture network modelling of the SCV site. (author).

31672 (STRIPA-TR–89-06) **Site characterization and validation - monitoring of head in the Stripa mine during 1988.** Persson, Ove (Swedish Geological Co., Uppsala (Sweden)); Olsson, Olle; Sehlstedt, Mikael. Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). Apr 1989. 138p. Order Number DE90626324. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The groundwater head has been monitored in 47 borehole sections surrounding the site which is investigated as a part of the Site Characterization and Validation project. This report contains basic data on the head monitoring system and graphical presentation of

the results obtained during 1988. (authors) (1 ref., 16 tabs., 109 figs.).

31673 (STRIPA-TR–89-07) **Site characterization and validation - geophysical single hole logging: Stage 3.** Andersson, Per (Swedish Geological Co., Uppsala (Sweden)). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). May 1989. 68p. Order Number DE90626325. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A total of 15 boreholes have been drilled for preliminary characterization of a previously unexplored site at the 360 and 385 m level in the Stripa mine. To adequately described the rock mass in the vicinity of these boreholes, a comprehensive program utilizing a large number of geophysical borehole methods has been carried out in 10 of these boreholes. The specific geophysical character of the rock mass and the major deformed units distinguished in the vicinity of the boreholes are recognized, and in certain cases also correlated between the boreholes. A general conclusion based on the geophysical logging results, made in this report, is that the preliminary predictions made in stage 2, of the site characterization and validation project (Olsson et.al, 1988), are adequate. The results from the geophysical logging can support the four predicted fracture/fracture zones GHa, GHb, GA and GB whereas the predicted zones GC and GI are hard to confirm from the logging results. (author).

31674 (STRIPA-TR–89-08) **Water flow in single rock joints.** Hakami, Eva (Luleaa Univ. (Sweden)). Swedish Nuclear Fuel and Waste Management Co., Stockholm (Sweden). May 1989. 142p. Order Number DE90626326. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

To study the hydromechanical properties of single rock joints a technique to make transparent replicas of natural joint surfaces has been developed. Five different joint samples were replicated and studied. The aperture distribution of the joints were obtained through a measurement method provided by the transparent replicas. The principle behind the method is that a water drop with a known volume, which is placed inside a joint, will cover a certain area of the surface depending on the average size of aperture at the actual point. Flow tests were performed on the same joint replicas. The tortuousity of the flow and the velocity along single stream lines were measured using colour injections into the water flow through the joints. The equivalent hydraulic apertures determined from the flow tests where shown to be smaller than the average mechanical apertures. The velocity of the flow varies strongly between different paths over the joint depending on the spatial distribution of the apertures. The degree of matedness between the joint surfaces is an important factor influencing the channeling character of the joints. (author) (38 refs.).

31675 (UCRL-LR–103168) **Line simplification and digital cartographic databases.** Walker, H. Lawrence Livermore National Lab., CA (USA). Nov 1989. 227p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010194. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

This thesis examines one component of the cartographic generalization process, line simplification, and its implementation with computer technology. The effectiveness of line simplification techniques in producing useful maps from digital map data is studied. Many techniques have been proposed to simplify lines; several of these have been implemented here. The approaches have been compared on their ability to simplify lines from two cartographic databases over both modest and extreme changes in scale. The comparisons are based on the simplification of individual lines, on the production of complete maps, and on mathematical measures of performance. One promising technique is enhanced to overcome certain limitations which are apparent during extreme scale change. The effect of map projections on the performance of such techniques is considered. While much additional work is needed, this study indicates that line simplification techniques can extend the range of scales over which certain cartographic databases can be utilized. 124 refs.

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31676 (AD-A–216856/5/XAB) **Isotopic fractionation by isotope-exchange reactions as a function of temperature: (2)H and (18)O in OH(-) + H_2O and $H_3O(+)$ + H_2O and (15)N in $N_2H(+)$ + N_2.** Henchman, M.; Paulson, J.F. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1989. 13p. (GL-TR–89-0342). Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Chemical Society, Faraday Transactions 2, Vol. 85, No. 10, 1673-1684(1989).

A simple model is used to predict the fractionation of isotopes as a function of temperature via ion-molecule reactions. It is developed for reactions proceeding via a single intermediate, where the isotopic mixing is completed within the lifetime of the intermediate such that the reaction is under thermodynamic control. The fractionation efficiency is K/(K + 1) where K is the equilibrium constant of the isotope-exchange reaction. The model is applied to deuterium and Oxygen 18 fractionation via the prototypical reactions OH(-)+H2O and H3O(+)+H2O; satisfactory agreement is found with the data available for 300 K. The model is also applied to Nitrogen 15 fractionation via N2H(+)+N2 and comparison is made with the data available for 80 K. The model predicts simply the fractionation efficiencies for such isotope exchange reactions at the temperatures of interstellar clouds (10-100K).

31677 (AD-A–217301/1/XAB) **Deep underwater muon and neutrino detection status and plans.** Talkington, H.R. Naval Ocean Systems Center, San Diego, CA (USA). Jan 1990. 8p. Available from NTIS, PC A02/MF A01.

DUMAND, the acronym for deep underwater muon and neutrino detection, is a project started by a group of U.S. physicists to produce a detector large enough to detect a significant rate of very high-energy natural neutrinos. This project will permit the study of elementary particle interactions in cosmic rays at energies beyond those available from contemplated future particle accelerators. It may also allow the observation of extraterrestrial and possibly extragalactic sources of neutrinos.

31678 (CBPF-NF–027/89) **Nonstandard big bang models.** Calvao, M.O.; Lima, J.A.S. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 15p. Order Number DE90625593. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The usual FRW hot big-bang cosmologies have been generalized by considering the equation of state $\rho = Anm + (\gamma-1)^{-1}p$, where m is the rest mass of the fluid particles and A is a dimensionless constant. Explicit analytic solutions are given for the flat case (ϵ=O). For large cosmological times these extended models behave as the standard Einstein-de Sitter universes regardless of the values of A and γ. Unlike the usual FRW flat case the deceleration parameter q is a time-dependent function and its present value, $q \simeq 1$, obtained from the luminosity distance versus redshift relation, may be fitted by taking, for instance, A=1 and γ = 5/3 (monatomic relativistic gas with $>> k_BT$). In all cases the universe cools obeying the same temperature law of the FRW models and it is shown that the age of the universe is only slightly modified. (author).

31679 (CNIC–00239) **Measurement of ionization distribution in the lower atmosphere caused by cosmic-ray.** Yue Qingyu (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Jin Hua. China Nuclear Information Centre, Beijing, BJ (China). 1988. 10p. (In Chinese). (IAE–0051). Order Number DE90625601. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Cosmic-ray ionization in the lower atmosphere was measured by the pressurized ionization chamber on lakes with different altitude and latitude in Yunnan province and Xinjiang Autonomy Region and on a high-altitude ballon. The variation of cosmic-ray ionization with latitude was also measured from Hainandao island to Manzhouli. An expression for distribution of cosmic-ray ionization with altitude and latitude was given by: $I(h, \lambda m, Y) = (I_0 + 0.0098\lambda m) \exp(7.27 \times 10^{-5} h^{1.184})I$.

31680 (GSI–90-10(prepr.)) **On the expansion of the universe during the confinement transition.** Jenkovszky, L.L.; Kaempfer, B.; Sysoev, V.M. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 9p. Order Number DE90785014. Available from NTIS (US Sales Only), PC A02/MF A01.

The possibility of a mini-inflationary era before and during the cosmic confinement transition is demonstrated. The inflationary growth of the space is caused by some supercooling of the quark-gluon matter. We study the temperature evolution by exploiting nucleation theory. (orig.).

31681 (INP–1344/PS, pp. 260-270) **Cosmic neutrinos.** Irvine, J.M. (Manchester Univ. (UK). Dept. of Physics). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The standard model of cosmology is briefly reviewed. The nature of cosmic neutrino background, the possibilities of its detection and its implications for nuclear physics laboratory are discussed. 2 figs. (author).

31682 (LA-UR–90-1123) **Particle energization.** Gisler, G. Los Alamos National Lab., NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9003151–1: Workshop on the interpretation of modern synthesis observations of spiral galaxies, Albuquerque, NM (USA), 11-15 Mar 1990). Order Number DE90010565. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A first-principles approach to the physics of particle energization is presented. The general physics of particle acceleration is then applied to a number of the classical astrophysical mechanisms for accelerating particles, with references to recent literature where these are used in specific circumstances. The solar flare is recommended as a microcosm for studying particle acceleration because many different processes seem to be occurring in close proximity, and there is abundant high time resolution data for diagnosing those processes. Finally, a list of possible sites and mechanisms for particle acceleration in spiral galaxies is presented. 66 refs., 6 figs., 3 tabs.

31683 (PB–90-156878/XAB) **Solar-Geophysical Data Number 543, November 1989. Part 1 (prompt reports). Data for October, September 1989, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Nov 1989. 172p. (SGD–543-PT-1). Available from NTIS, PC A08/MF A01.

See also PB–90-108572 and PB–90-156886.

Contents: solar-terrestrial environment; iuwds alert periods (advance and worldwide); solar activity indices; solar flares; solar radio emission; stanford mean solar magnetic field.

31684 (PB–90-171679/XAB) **Solar-Geophysical data number 544, December 1989. Part 2 (comprehensive reports). Data for June 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Dec 1989. 155p. (SGD–544-PT-2). Available from NTIS, PC A08/MF A01.

See also PB–90-171661 and PB–90-156886.

Contents: detailed index for 1989; data for June 1989 – solar flares, solar radio bursts at fixed frequencies, interplanetary solar particles and plasma, solar x-ray radiation from GOES satellite, mass ejections from the sun, active prominences and filaments, solar irradiance; miscellaneous data – meudon carte synoptique carrington rotations 1814-15 April-May 1989, solar proton events affecting the earth's environment (GOES satellites) - January 1976 - November 1989.

31685 (UCRL-ID–103509) **Advanced multilayer x-ray optics.** Barbee, T.W. Jr. Lawrence Livermore National Lab., CA (USA). 30 Mar 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008228. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Multilayer optics for the x-ray, soft x-ray and extreme ultra violet is a rapidly expanding and maturing field. A large part of the effort in this field is directed to improving the quality of multilayer structures by developing a better understanding of synthesis-structure-property relationships. Although the quality of simple multilayer structures may improved be there are now significant instrumental applications for these reflecting structures and opportunities for the development of new optics. In this paper results on a new class of diffraction grating, the multilayer grating, and two instruments, a multilayer two element fixed exit beam monochromator and a multilayer Cassegrain astronomical telescope, are presented and the implications of this work discussed. 31 refs., 5 figs.

31686 Synchrotron radiation spectrum for galactic-sized plasma filaments–. Peter, W. (Univ. of California, Dept. of Physics, Irvine, Irvine, CA (US)); Peratt, L. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 49-55 (Feb 1990).

A detailed analysis of the radiation spectrum for synchrotron-emitting electrons in galactic-sized Birkeland current filaments is presented. It is shown that the number of filaments required to thermalize the emission spectrum to blackbody is not reduced when a non-Maxwellian electron distribution is assumed. If the cosmic background radiation (CBR) spectrum (T = 2.76 K) is due to absorption and reemission of radiation from galactic-sized current filaments, higher order synchrotron modes are not as highly self-absorbed as lower-order modes, resulting in a distortion of the blackbody curve at higher frequencies. This is especially true for a non-Maxwellian distribution of electrons for which the emission coefficient at high frequencies is shown to be significantly less than that for a Maxwellian distribution. The deviation of the CBR spectrum in the high- frequency regime may thus be derivable from actual astrophysical parameters, such as filamentary magnetic fields and electron engergies in our model.

31687 Prediction of the submillimeter spectrum of the cosmic background radiation by a plasma model–. Lerner, E.J. (Lawrenceville Plasma Physics, Lawrenceville, NJ (US)). *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 43-48 (Feb 1990).

A non-Big Bang plasma model is used to predict the submillimeter spectrum of the cosmic background radiation (CBR). Early intermediate mass stars heat dust which, in turn, warms electrons trapped in force-free filaments emitted by galactic nuclei. Current stars contribute further heating by the same synchrotron mechanism. The electrons emit a nonblackbody radiation which matched the observed CBR's spectrum and isotropy. The model also predicts intergalactic absorption of radio radiation, as confirmed by observations of spiral galaxies, and accurately predicts the spectrum of radio-quiet sources.

31688 The evidence for electrical currents in cosmic plasma–. Peratt, A.L. (Los Alamos National Lab., NM (USA)). *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 26-32 (Feb 1990).

With the advent of fully three-dimensional, fully electromagnetic, particle-in-cell simulations, investigations of Birkeland currents and magnetic-field-aligned electric fields have become possible in plasmas not accessible to in situ measurement; i.e., in plasmas having the dimensions of galaxies or systems of galaxies. The importance of applying electromagnetism and plasma physics to the problem of radiogalaxy and galaxy formation derives from the fact that the universe is largely matter in its plasma state; i.e. a plasma universe. The motion of this plasma across weak magnetic fields can lead to the generation of electromotive forces, the energy of which can be transported over large distances via Birkeland currents. The dissipation of this energy in localized regions can lead to pinches and condensed states of matter. Where double layers form in the pinches, strong electric fields can accelerate the charges particles to high energies. The necessity for a three-dimensional electromagnetic approach derives from the fact that the evolution of magnetized plasmas involves complex geometries, intense self-fields, nonlinearities, and explicit time-dependence. The observational evidence for galactic-dimensioned Birkeland currents is given based on the comparison of the synchrotron radiation properties of simulated currents to those of extra-galactic sources.

31689 The great supernova of 1987. Woosley, S.; Weaver, T. *Scientific American (USA),* 261(2): 32-40 (Aug 1989).

On February 23, 1987, a burst of light and a pulse of elusive particles called neutrinos reached the earth from the brightest supernova in 383 years. Light from the explosion, 160,000 light-years away in the Large Magellanic Cloud was visible only in the Southern Hemisphere. Now more than two years after the discovery, the supernova has been studied at all wavelengths of the electromagnetic spectrum, and it is the first astronomical source of neutrinos to have been detected other than the sun. Together the observations give a coherent picture of the grand event, a picture that vindicates theory but also holds some surprises. In the broadest terms SN 1987A is a type II supernova, powered by the gravitational collapse of a stellar core. To make sense of what was observed in SN 1987A, it is best to begin with the history of the star that exploded. The story that follows in this paper is based on computer simulations of the evolution of a hypothetical massive star. 7 figs.

31690 Cosmic-string evolution: A numerical simulation. Allen, B. (Department of Physics, University of Wisconsin-Milwaukee, Post Office Box 413, Milwaukee, Wisconsin 53201 (USA)); Shellard, E.P.S. *Physical Review Letters (USA),* 64(2): 119-122 (8 Jan 1990). DOE Contract AC02-76ER03069.

A system of intercommuting cosmic strings is numerically evolved in a homogeneous radiation-dominated expanding universe. Further evidence for the existence of a "scaling" solution is presented, and results for the long-string energy density are given. Long strings exhibit significant small-scale structure—kinks and short-wavelength propagating modes. Net loop production is observed to be strongly peaked at scales considerably smaller than the horizon, and reasons for this severe fragmentation are briefly discussed. The new numerical techniques employed are also described.

31691 Instabilities in line-driven stellar winds. IV. Linear perturbations in three dimensions. Rybicki, G.B. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA (USA)); Owocki, S.P.; Castor, J.I. *Astrophysical Journal (USA),* 349: 274-285 (Jan 1990).

Nonradial wave propagation in line-driven stellar winds is analyzed including both finite disk effects and the line-drag effect of scattered line radiation. Within the local (WKB) analysis the results apply to wavelengths both longer and shorter than the Sobolev length. The finite disk causes short-wavelength waves with lateral velocity polarization to be unstable in the idealized case of pure absorption; however, the growth rates are smaller than for radially polarized waves, and the instability is damped by a relatively small amount of scattering. Hence, in realistic stellar winds, where the driving is primarily by scattering lines, perturbations with an arbitrary mixture of lateral and radial polarizations at the wind base should quickly become nearly radially polarized farther out in the wind. The implications of these results are discussed, both for interpretation of observational signatures of wind structure and for theoretical calculations aimed at modeling the nonlinear evolution of wind instabilities. 32 refs.

31692 Universe decay and changing the cosmological constant. McGuigan, M. (The Rockefeller University, 1230 York Avenue, New York, New York 10021 (US)). *Physical Review, D (Particles Fields) (USA),* 41(2): 418-429 (15 Jan 1990). DOE Contract AC02-87ER40325.

If superspace time is taken to be $\sqrt{\det(\gamma)}$, where γ_{ij} is the three-metric, then the cosmological constant plays the role of a $(\text{mass})^2$ term in the Wheeler-DeWitt equation. Second quantization allows particles of different mass to decay into one another if they are interacting. Likewise, adding interactions to the third-quantized Lagrangian allows universes with different cosmological constants to decay into one another. We consider a simple model with two types of universes, one of cosmological constant zero and the other nonzero. We compute the probability of decay and production for each type of universe.

31693 Galactic neutron stars and gamma-ray bursts. Hartmann, D. (Lick Observatory, Santa Cruz, CA (USA)); Woosley, S.E.; Epstein, R.I. *Astrophysical Journal (USA),* 348: 625-633 (Jan 1990).

The association of the gamma-ray burst phenomenon with Galactic neutron stars is investigated statistically, and the distance to presently observable gamma-ray bursts is constrained. This is done by calculating the spatial distribution and kinematic properties of a sample of Population I neutron stars and comparing their properties to those of observed gamma-ray bursts. Both brightness distribution and angular distribution on the celestial sphere are employed. Current observations suggest negligible correlation on small angular scales, large-scale isotropy, and a radial distribution that is approximately uniform to the distances currently observed. It is concluded that the distribution of Population I neutron stars is consistent with current observations if gamma-ray bursts occur continuously throughout the neutron star lifetime and if the current sampling depth is at least about 150 pc but not more than roughly 2 kpc. 77 refs.

31694 Dynamic mass exchange in doubly degenerate binaries. I - 0.9 and 1.2 solar mass stars. Benz, W. (Harvard-Smithsonian Center for Astrophysics, Cambridge, MA (USA)); Cameron, A.G.W.; Press, W.H.; Bowers, R.L. *Astrophysical Journal (USA),* 348: 647-667 (Jan 1990).

The dynamic mass exchange process in doubly degenerate binaries was investigated using a three-dimensional numerical simulation of the evolution of a doubly degenerate binary system in which the primary is a 1.2-solar-mass white dwarf and the Roche lobe filling secondary is a 0.9-solar-mass dwarf. The results show that, in a little more than two orbital periods, the secondary is completely destroyed and transformed into a thick disk orbiting about the primary. Since only a very small fraction of the mass (0.0063 solar mass) escapes the system, the evolution of the binary results in the formation of a massive object. This object is composed of three parts, the initial white dwarf primary, a very hot pressure-supported spherical envelope, and a rotationally supported outer disk. The evolution of the system can be understood in terms of a simple analytical model where it is shown that the angular momentum carried by the mass during the transfer and stored in the disk determines the evolution of the system. 34 refs.

31695 $U(1)'$ dark matter. Brahm, D.E. (Physics Department, University of California, Berkeley, California 94720 (US)— Theoretical Physics Group, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720); Hall, L.J. *Physical Review, D (Particles Fields) (USA),* 41(4): 1067-1076 (15 Feb 1990). DOE Contract AC03-76SF00098.

We consider models with a gauged $U(1)'$, to which is coupled a fermionic standard-model singlet ψ. If ψ's close the Universe, a Lee-Weinberg calculation gives the four-fermion coupling G' from the mass m_ψ. We can then calculate the germanium scattering cross section as a function of m_ψ. The results are nearly model independent and close to experimental limits for 10 GeV$\leq m_\psi \leq$100 GeV. In the region 400 GeV$\leq m_\psi \leq$40 TeV the scattering cross section depends on $M_{Z'}$, and again approaches experimental limits if $M_{Z'} \leq$2 TeV.

31696 Evolution of domain walls in the early Universe. Kawano, L. (Department of Physics, Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637-1433 (US)— NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Batavia, Illinois 60510-0500). *Physical Review, D (Particles Fields) (USA),* 41(4): 1013-1021 (15 Feb 1990).

The evolution of domain walls in the early Universe is studied via two-dimensional computer simulation. The walls are initially configured on a triangular lattice and then released from the lattice, their evolution driven by the wall curvature and by universal expansion. The walls attain an average velocity of about 0.3c and their surface area per volume (as measured in comoving coordinates) goes down with a slope of -1 with respect to conformal time regardless of whether the Universe is matter or radiation dominated. The additional influence of vacuum pressure causes the energy density to fall away from this slope and steepen, thus allowing a situation in which domain walls can constitute a significant portion of the energy density of the Universe without provoking an unacceptably large perturbation upon the microwave background.

31697 Wormholes, baby universes, and causality. Visser, M. (Theoretical Division, T-8, Mail Stop B-285, Los Alamos National

Laboratory, Los Alamos, New Mexico 87545 (US)). *Physical Review, D (Particles Fields) (USA)*, 41(4): 1116-1124 (15 Feb 1990).

In this paper wormholes defined on a Minkowski signature manifold are considered, both at the classical and quantum levels. It is argued that causality in quantum gravity may best be imposed by restricting the functional integral to include only causal Lorentzian spacetimes. Subject to this assumption, one can put very tight constraints on the quantum behavior of wormholes, their cousins the baby universes, and topology-changing processes in general. Even though topology-changing processes are tightly constrained, this still allows very interesting geometrical (rather than topological) effects. In particular, the laboratory construction of baby universes is *not* prohibited provided that the "umbilical cord" is never cut. Methods for relaxing these causality constraints are also discussed.

31698 **Energy spectra of cosmic rays above 1 TeV per nucleon.** Burnett, T.H. (Washington Univ., Seattle (USA)); Dake, S.; Derrickson, J.H.; Fountain, W.F.; Fuki, M. *Astrophysical Journal (USA)*, 349: L25-L28 (Jan 1990).

Direct measurements of cosmic-ray nuclei above 1 TeV/nucleon have been performed in a series of balloon-borne experiments with emulsion chambers. The observed all-particle spectrum above 20 TeV is consistent with the results of the Proton satellite and many air shower experiments. The proton spectrum is consistent with a power law having an index of 2.76 + or - 0.09 up to at least 100 TeV, but an overabundance of helium by a factor of 2 above 2 TeV per nucleon is found when compared with the extrapolation from the low energies. For heavy elements (C through Fe), the intensities around 1 TeV/nucleon are consistent, within the statistical errors, with the extrapolation from lower energy data using the Spacelab 2 spectral indices. An enhancement for the medium-heavy components (C through Ca) above 200 TeV is indicated. The mean mass above 50 TeV indicates slightly higher values than the results of the air shower experiments. 37 refs.

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Refer also to citation(s) 31683

31699 (AD-A-217079/3/XAB) **Two-dimensional simulations of a charge-neutral plasma beam injected into a transverse magnetic field. Final report.** Livesey, W.A.; Pritchett, P.L. California Univ., Los Angeles, CA (USA). Inst. of Physics and Planetary Physics. Oct 1989. 35p. Available from NTIS, PC A03/MF A01.

It has been suggested that a charge-neutral beam consisting of ions and electrons may serve as an alternate to the plasma contractor for collecting electrons from the ionosphere. The collecting area of the beam would be determined by the distance it can penetrate the local magnetic field. A charge-neutral beam can transverse a magnetic field by virtue of collective effects for the proper parameter regime. This phenomenon is studied using a two-dimensional (three-velocity) electrostatic code. A polarization electric field forms across the beam as it penetrates the magnetic field. In vacuum the beam penetrates 4.5 sub i into the field, rho a gyroradius of a beam ion traveling at injection velocity. Loss of ions from the polarization layer produces a net electron current in the beam. The beam curves slightly due to the resulting j x B force. Injection into a tenuous plasma with a plasma-to-beam density ratio of 1/100 shortens the penetration length to 2.7 rho. The plasma partially shields the polarization field of the beam. Consequently, more beams ions are lost. The net beam current is enhanced resulting in a more pronounced curvature. Injection into a marginally dense plasma with a density ratio of 1/10 results in a pronounced deflection of the beam.

31700 (AD-A-217116/3/XAB) **Effects of magnetic storm phases on F-layer irregularities from auroral to equatorial latitudes. Quarterly report, 1 July-31 December 1989.** Aarons, J.; Mendillo, M. Boston Univ., MA (USA). Center for Space Physics. 31 Dec 1989. 3p. Available from NTIS, PC A01/MF A01.

No abstract available.

31701 (AD-A-217398/7/XAB) **Solar cyclical trend study of the mid-latitude, quiet-time, meridional, neutral winds at winter solstice conditions. Master's thesis.** Breninger, R.L. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). 1989. 84p. (AFIT/CI/CIA-89-031). Available from NTIS, PC A05/MF A01.

Located within the region of the thermosphere is the major portion of the ionosphere. Distribution of the ionospheric plasma within this region is a function of atmospheric mass and energy transport. For the current study, the component of the neutral wind along the magnetic meridian is derived from ground-based ionosonde measurements of the F2 peak layer height. Meridional wind variations with respect to location, universal time, and level of solar activity are the focal points on this investigation. The primary timescale of interest covers a period of one solar cycle, from 1977 to 1987. Data from one station have been extended to 1965 to study the repetitive nature of solar activity on the meridional winds. Results of this study indicate a definite variation of wind speed and direction, which correlates with changing levels of solar activity. It is hoped that the results of this study will aid current efforts to develop ionospheric models and enhance their forecasting capabilities.

31702 (AD-A-217558/6/XAB) **Simultaneous radar and satellite observations of the polar cusp/cleft at Sondre Stromfjord. Interim scientific report.** Valladares, C.E.; Basu, S.; Niciejewski, R.J.; Sheehan, R.E. Emmanuel Coll., Boston, MA (USA). 1989. 15p. Available from NTIS, PC A03/MF A01.

Pub. in Electromagnetic Coupling in the Polar Clefts and Caps, 285-298(1989).

On February 9, 1988 a multi-instrument observation of the dayside polar ionosphere was made at Sondre Stromfjord, Greenland as part of a CEDAR high latitude campaign. Our objective was to observe the low altitude signature of the cusp during southward IMF but under fairly quiet ionospheric conditions (Kp=2). The HiLat satellite measured in-situ particle precipitation, field-aligned currents and velocity shears in the dayside cusp/cleft, while the VHF beacon on board showed large phase scintillation and saturated intensity scintillation. The phase spectral index was fairly shallow indicating that large power spectral density was present up to scales on the order of 100m. during the spacecraft overflight, the radar was scanning close to the F region projection of the satellite track. It is the object of this paper to compare the radar measured thermal density, Ti and Te features in the F region with topside density and velocity structures and particle precipitation characteristics measured in-situ by the satellite at 830 km. The precipitating electron flux measured by HiLat was also input to an ionospheric chemistry model that calculates electron density and temperature profiles for different exospheric temperatures. The modeling results show that most of the features of the radar data may be explained in terms of cleft precipitation, consequent higher exospheric temperatures and enhanced convection.

31703 (PPPL-2691) **Kinetic theory of geomagnetic pulsations: I. Internal excitations by energetic particles.** Chen, Liu (Princeton Univ., NJ (USA). Plasma Physics Lab.); Hasegawa, Akira. Princeton Univ., NJ (USA). Plasma Physics Lab. May 1990. 33p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90010280. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Motivated by recent satellite observations, we have carried out a comprehensive theoretical analysis on the generation of hydromagnetic Alfven waves in a realistic magnetospheric plasma environment consisting of a core and an energetic components. Our theoretical formulation employs the gyrokinetic equations and, thus, retains nonuniform plasma equilibria, anisotropy, finite Larmor radii, magnetic trapping as well as wave-particle interactions. A set of coupled equations for transverse and compressional magnetic perturbations is derived and analyzed for its stabilities assuming interchange stable equilibrium distribution functions. Our findings are compressional and tranverse shear Alfven oscillations are generally coupled in realistic plasmas. In the decoupled limit, for the compressional wave branch, one recovers the drift-mirror instability due to the Landau resonances and $\tau \equiv 1 + 4\,\pi(\partial P_\perp/B\partial B) < 0$. Here, $P_\perp = P_\perp(\psi,B)$ is the perpendicular pressure and ψ is the magnetic flux function. For the decoupled transverse shear Alfven branch, one obtains the drift Alfven ballooning instability due to the Landau resonances and free energy of the pressure gradient for $\tau > 0$. For both branches, the most unstable modes have antisymmetric structures and propagate in the diamagnetic drift direction of the

energetic ions. Finite coupling can be shown to further enhance the drift Alfven ballooning instabilities. Thus, we conclude that for $\tau \geq 0$, the coupled drift Alfven ballooning-mirror instability constitutes an important internal generating mechanism of geomagnetic pulsations. The various predicted features of this instability are also found to be consistent with satellite observations.

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Refer also to citation(s) 30444, 30449, 30688, 30726, 30774, 30775, 30809, 30826, 30861, 30862, 30863, 30864, 30919, 31232, 31304, 31911, 31913, 31940, 31947, 31967, 32024

31704 (AD-A–217223/7/XAB) **Relativistic many-body perturbation-theory calculations on Be, Ne^{6+}, Ar^{14+} and Ne.** Ishikawa, Y.; Sekino, H.; Binning, R.C. Puerto Rico Univ., Rio Piedras (Puerto Rico). Dept. of Chemistry. 4 Aug 1989. 5p. Available from NTIS, PC A01/MF A01.

Pub. in Chemical Physics Letters, Vol. 160, No. 2, 206-211(4 Aug 1989).

Relativistic diagrammatic perturbation theory calculations have been performed on the ground states of the beryllium atom and the isoelectronic species Ne6+ and Ar14+. Reference states of single-configuration Dirac-Fock wavefunctions were computed by expansion in basis sets of Gaussian functions. Second- and third-order radial correlation corrections were computed and compared to results obtained by Quiney et al. using a large basis of Slater-type functions. Second- and third-order radial and angular corrections for Ne have been computed with moderately large well-tempered Gaussian basis sets of varying expansion lengths.

31705 (AD-A–217510/7/XAB) **Electron-impact ionization and electron-attachment cross sections of radicals important in transient gaseous discharges. Final technical report, 1 September 1986-31 December 1989.** Lee, L.C.; Srivastava, S.K. San Diego State Univ., CA (USA). Dept. of Electrical and Computer Engineering. 25 Jan 1990. 67p. Available from NTIS, PC A04/MF A01.

Electron-impact ionization and electron attachment cross sections of radicals and excited molecules were measured using an apparatus that consists of an electron beam, a molecular beam and a laser beam. The information obtained is needed for the pulse power applications in the areas of high-power gaseous discharge switches, high-energy lasers, particle beam experiments, and electromagnetic pulse systems. The basic data needed for the development of optically-controlled discharge switches were also investigated in this program. Transient current pulses induced by laser irradiation of discharge media were observed and applied for the study of electron-molecule reaction kinetics in gaseous discharges.

31706 (CONF-8910396–1) **Laser spectroscopy at accelerator facilities.** Berry, H.G. Argonne National Lab., IL (USA). [1989]. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Conference on lasers in science and technology; Amman (Jordan); 21-27 Oct 1989. Order Number DE90010462. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The use of lasers in exciting fast atomic and molecular ions produced in accelerators is discussed. Collinear excitation of the ions is most efficient, and several examples of laser-induced fluorescence are given. These include tests of relativistic atomic structure, and atomic and molecular hyperfine measurements. Higher precision can be attained using rf double-resonance techniques in some cases. A variant of this technique, the raman double-resonance technique, is also introduced. The production of an optically-pumped polarized target is also described, together with an experiment on polarized electron pick-up in a fast heavy-ion beam. 16 refs., 19 figs., 1 tab.

31707 (CONF-9003154–1) **Thoughts on future ESSR [Electron Spectrometry with Synchrotron Radiation] studies of inner core levels.** Krause, M.O. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Workshop on atomic physics at the advanced photon source; Argonne, IL (USA); 23-30 Mar 1990. Order Number DE90010711. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses electron spectrometry with synchrotron radiation studies of inner are levels of rare gases and other selected elements.

31708 (DOE/ER/13971–6) **Measurements of scattering processes in negative ion-atom collisions: Technical progress report, 1 September 1989–31 August 1990.** Kvale, T.J. Toledo Univ., OH (USA). Dept. of Physics and Astronomy. [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13971. Order Number DE90010666. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This report describes the progress made on the research objectives during the second year of the grant. This research is designed to study scattering processes which occur in negative ion-atom collisions in the intermediate energy region. These include: elastic scattering, electron detachment, and possible target inelastic processes. The experimental technique is Ion Energy-Loss Spectroscopy (IELS), which will positively identify the elastic scattering channel as well as any target inelastic processes. The measurements will provide total cross sections initially, and once the angular positioning apparatus is installed, will provide angular differential cross sections. In order to accomplish these goals, construction of an apparatus was necessary, and much of the progress this year involved this construction. 8 refs.

31709 (DOE/ER/25019–17) **Nonlinear resonance: Progress report, August 1, 1989–March 31, 1990.** Kevorkian, J. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. 12 Apr 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-86ER25019. Order Number DE90010428. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This progress report covers the period August 1, 1989 to March 31, 1990. The subjects discussed are: transient and sustained resonance for systems with very slowly varying parameters; free-electron lasers with very slow wiggler taper; and bursting oscillations in biological systems. Plans are discussed for: FEL applications; transient and sustained resonance; and bursting oscillations. (FSD)

31710 (DOE/ER/60473–3) **Selective excitation, relaxation, and energy channeling in molecular systems: Comprehensive progress report, May 1987–April 1990.** Rhodes, W.C. Florida State Univ., Tallahassee, FL (USA). Inst. of Molecular Biophysics. Apr 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER60473. Order Number DE90010793. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the following topics: davydov soliton theory; squeezed states; multimode molecular quantum mechanics; the phase operator of quantum mechanics; and quantum thermodynamics.

31711 (INIS-BR–2047) **F center deexcitation induced by local vibration tunneling.** Gomes, L.; Morato, S.P. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). [1990]. 12p. Order Number DE90625342. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new concept of electronic deexcitation of defects has been made for systems where the electron couples very strong with a local lattice mode. The model is based on a classical - quantum description of the configuration curve diagram which proposes that an electronic transition may be induced when the wave packets of both oscillators involved are overlaping. It was successfully applied to the F center system, at iow temperatures, in almost all the alkali halides. The luminescence efficiency derived from the model explains very well the observation, even the fact that the F* - electron always reaches the relaxed excited state. (author).

31712 (LAMP–89/1) **Critical analysis of the OH fundamental vibrational spectrum of supercooled liquid water.** LAMP series report (Laser, Atomic and Molecular Physics). Wiafe-Akenten, J. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 22p. Order Number DE90625343. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The OH stretching vibrations of liquid H_2O have been investigated with Raman Spectroscopic Technique from +65 deg. C down to -20 deg. C. From our experimental results, we suggest in agreement with Yeh et. al., 1932 that in the low temperature region, clusters of tetrabounded water molecules are formed. This will explain the intensity enhancement and the anomalous structure reported by Bosio and coworkers in the supercooled region (Bosio, Teixeira and Stanley, 1981). Based on our measurements, we propose that the 3200 cm^{-1} spectral component which is absent from the OH vibrational spectrum of HOD (Murphy and Bernstein, 1972) but which prominently appears in the OH stretching vibrational spectrum of liquid H_2O in a coupling band. The spectral band centers of both the 3200 cm^{-1} and the 3400 cm^{-1} components of the OH stretching vibrations in liquid H_2O decrease with decreasing temperature indicating strengthening of hydrogen bonding on the average with decreasing temperature. The rate of decrease of frequency with temperature is greater with the coupling band and this result together with behaviour of the band width leads us to conclude that the coupling band component is the more hydrogen bonded component of the spectrum. The high frequency spectral shoulder at about 3600 cm^{-1} is found to increase with increasing temperature. (author). 16 refs, 4 figs, 1 tab.

31713 (LAMP–89/3) **Rotation effect in the vibration-rotation wave function of a diatomic molecule.** LAMP series report (Laser, Atomic and Molecular Physics). Korek, M. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 35p. Order Number DE90625344. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The aim of this work is to dissociate, in the wave function describing the vibration-rotation motion of a diatomic molecule, the effect of the rotation from the pure vibration wave function and to give the analytic expression of this rotational effect. 14 refs, 5 figs, 14 tabs.

31714 (UCRL-JC–103520) **A new approach for the determination of electronic structure.** Gonis, A. (Lawrence Livermore National Lab., CA (USA)); Sowa, E.C.; Zhang, X.-G. Lawrence Livermore National Lab., CA (USA). 6 Apr 1990. 34p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900455–1: 20. annual international symposium on electronic structures of solids, Gaussig (German Democratic Republic), 16-20 Apr 1990). Order Number DE90010479. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We present a new real-space multiple scattering theory method for the solution of the Schroedinger equation and the calculation of the electronic structure of solid materials. We discuss the fundamental basis of the method and illustrate it with the results of numerical calculations. 23 refs., 6 figs.

31715 **Interaction of deuterium with buried oxides in silicon.** Myers, S.M. (Sandia National Labs., Albuquerque, NM (USA)). pp. 524 of Silicon-on-insulator anel buried metals in semiconductors. Sturm, J.C.; Chen, C.K.; Hemment, D.L.F. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC04-76DP00789. (CONF-8711161–: MRS silicon-on-insulator and buried metals in semiconductors symposium, Boston, MA (USA), 30 Nov - 1 dec 1987).

The authors report on silicon with buried oxides formed by ion implantation (SIMOX) or zone-melt recrystallization (ZMR) exposed to deuterium gas at temperatures from 773 K to 1273 K, and the depth profile of the D was then determined by nuclear reaction analysis. The D was localized within the buried oxide with no measurable quantity in the Si phase. Uptake was controlled by permeation through the Si overlayer, and the permeability of D in Si was determined at 873 K. The sample dependence of D uptake indicated substantially fewer defect-trap sites in SIMOX oxide annealed at 1678 K as opposed to 1548 K, with still smaller defect densities in the ZMR oxide. Hydrogen exposure at 1273 K substantially disrupted the SIMOX structures.

31716 **IR and SIMS study of hydrogen diffusion in rf sputter deposited boron doped a-Si:H and undoped a-Ge:H.** Mitra, S. (Ames Lab., US DOE and Physics Dept., Iowa State Univ., Ames, IA (US)); Wu, X.L.; Shinar, J.; Shinar, R. pp. 742 of Amorphous silicon technology-1989. Madan, A.; Thompson, M.J.; Taylor, P.C.; Hamakawa, Y.; LeComber, P.G. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-890426–: Spring meeting of the Materials Research Society, San Diego, CA (USA), 24-28 Apr 1989).

Secondary ion mass spectrometry (SIMS) and IR measurements of long range deuterium motion in rf sputter deposited (rf sp) p-doped a-Si:H and undoped a-Ge:H are compared to recently published results on undoped rf sp a-Si:H, which exhibited strongly power-law time dependent diffusion constants (exponent $\alpha \simeq 0.75 \pm 0.1$) in films of as-deposited content of di-H and tri-H bonds (usually associated with microvoids) $N_{do} \sim$4-5 at.%. In p- doped a-Si:H samples where $N_{do} \sim$1.8-3.8 at.%, the diffusion is much faster, but the exponent is similar. In undoped a-Ge:H exhibiting a stretch vibration band indicative of mono-H bonding only, the diffusion is about one order of magnitude faster than in undoped a-Si:H, and $\alpha \simeq 0.23$. The results are discussed in relation to both the multiple rapping (dispersive) and defect mediated diffusion models.

31717 **Partial cross sections for the photodetachment of metastable He^-.** Pegg, D.J. (Department of Physics, University of Tennessee, Knoxville, Tennessee 37996 (USA)); Thompson, J.S.; Dellwo, J.; Compton, R.N.; Alton, G.D. *Physical Review Letters (USA),* 64(3): 278-281 (15 Jan 1990). DOE Contract AC05-84OR21400.

Partial cross sections for the photodetachment of a 2*s* or 2*p* electron from metastable $(1s2s2p)^4P$ He^- ions have been determined using crossed-beam photoelectron spectroscopy. Kinematic effects associated with detachment from a fast beam source have been exploited, in a novel way, to enhance the precision of the measurements. Calculated cross sections for the photodetachment of H^- were used to establish a scale for the He^- measurements. Radiative attachment cross sections from the photodetachment results using the principle of detailed balance.

31718 **Multiple Wannier power laws for 3*e* escape.** Feagin, J.M. (Department of Physics, California State University, Fullerton, California 92634 (US)); Filipczyk, R.D. *Physical Review Letters (USA),* 64(4): 384-387 (22 Jan 1990).

A pair of generalized coordinates is introduced to describe Wannier threshold effects in three- and four-particle systems. In the case of four-particle breakup, they indicate the presence of multiple *unstable* normal modes in the breakup configuration and thus reveal a new feature in the Wannier formalism: the occurrence of a secondary Wannier power law. This prediction is in accord with recent experimental observations of a break in the cross section near threshold for triple photoionization in oxygen and in neon.

31719 **Two-color studies of autoionizing states in small molecules.** Pratt, S.T. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); O'Halloran, M.A.; Tomkins, F.S.; Dehmer, J.L.; Dehmer, P.M. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 451-456 (20 Oct 1989). DOE Contract W-31109-ENG-38. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Two-color resonantly enhanced multiphoton ionization (REMPI) is used to study rotational autoionization of molecular hydrogen and nitric oxide. In contrast to conventional, single-photon techniques, the REMPI technique can be used to study autoionizing levels of H_2 that can decay only through very weak interactions such as *p-f* mixing and singlet-triplet mixing. In addition, rotational autoionization that occurs with that change in rotational quantum number greater than 2 can also be examined (i.e., $\Delta N^+ > 2$). In homonuclear molecules, symmetry considerations require that ΔN^+ be even; in heteronuclear molecules, ΔN^+ may be even or odd. It is found, however, that NO is in some sense quasi-homonuclear, and that processes with ΔN^+ = even appear to be more efficient than processes with ΔN^+ = odd.

31720 **Molecular two-photon spectroscopy.** McCann, M.P. (Chemical Physcis Section, Oak Ridge National Laboratory, Oak Ridge, Tennesse, USA 37831-6378 (US)); Chen, C.H.; Payne, M.G. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 460-462 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Two-photon transitions are examined in molecular oxygen in the region of 8 to 9 eV. Using a pulsed nozzle-quadrupole mass spectrometer apparatus, absolute two-photon constants can be determined.

31721 Theory of molecular transition moment determination by Autler–Townes spectroscopy: D $^1\Pi_u$–E,F$^1\Sigma^+_g$ bands of H_2. Lau, A.M.F. (Combustion Research Facility, Sandia National Laboratories, Livermore, CA 94550 (US)); Huo, W.M. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 463-465 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We investigate the determination of vibronic transition moments between two electronic states of a molecule by the Autler–townes effect (also known as ac, optical or dynamical Stark splitting). For some representative bands of H_2 D$^1\Pi_u$–E,F $^1\Sigma^+g0$, we calculate their Autler–Townes spectra and examine their dependences on laser detuning, intensity, bandwidth, and the Doppler effect. As input to our calculation, the D–E,F electronic transition moment and the (v'=0–14, v=1,4 and 6) vibronic transition moments have been computed. Our investigation shows that with moderte laser requirement, the Autler–Townes splitting of a large number of D–E,F vibronic transitions in H_2 should be observable so that their transition moments may be deduced.

31722 Multiphoton ionization (MPI) of vibrationally excited NO (v''=0–9) in a pulsed molecular beam. Feigerle, C.S. (University of Tennessee, Knoxville, Tennessee 37996-1600 (US)); Miller, J.C. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 457-459 (20 Oct 1989). (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Vibrationally excited (v''=0–9) yet rotationally cold (<100K) NO has been produced by electrically discharging N_2O in a pulsed molecular beam. The MPI spectrum of this sample has been recorded from 420 to 460nm and 212 to 225nm. Numerous new bands have been observed in this region and assigned as A←X and C←X transitions originating from vibrationally excited NO. In particular the 420 to 460nm region is dominated by C←X hot band transitions which produced NO^+ in a (2+1) ionization scheme. Comparison of spectra of (1+1) ionization through the A state with computer simulations show the one-proton resonance transition to be nearly saturated.

31723 Multiphoton ionization photoelectron spectroscopy of xenon: Experiment and theory. Bajic, S.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6125 (US)—Department of Chemistry, The University of Tennesses, Knoxville, Tennessee 37996 (US)); Compton, R.N.; Tang, X.; L'Huiller, A.; Lambropoulos, P. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 466-468 (20 Oct 1989). DOE Contract AC05-84OR21400. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Photoelectron energy and angular distributions for resonantly enhanced multiphoton ionization (REMPI) of xenon via the three-photon-allowed $7s[^3/_2]^0_1$ and $5d[^3/_2]^0_1$ states have been studied both experimentally and theoretically. The electron kinetic energy spectra give the probability of leaving Xe^+ in either the $^2P_{1/2}$ or $^2P_{3/2}$ core. The measured branching ratio for leaving each ionic core is used to test the theoretical description of the REMPI process. Measurements of *both* the angular distribitions and the [3+1] REMPI via the 5d state are adequately reproduced by multichannel quantum defect theory. However, measurements of angular distributions for the electrons resulting from [3+1] via the $7s[^3/_2]^0_1$ state into $Xe^+{}^2P_{3/2}$ (core preserving) or Xe^+ $^2P_{1/2}$ (core changing) are in striking disagreement with theory.

31724 Emittance characteristics of negative ion beams generated by the sputter technique. Alton, G.D. (Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831-6368 (US)). *Review of Scientific Instruments (USA)*, 61(1): 505-507 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Average emittance data for ion beams extracted from cesium-sputter negative ion sources equipped with spherical, ellipsoidal, and cylindrical geometry cesium-surface ionizers are presented. The attributes of the respective source geometries are described in terms of their cesium ion optical properties. The results of recent measurement of the emittances of momentum-analyzed beams extracted from the ellipsoidal geometry source are also presented. These measurements indicate the presence of a species-dependent effect. The effect is believed to be attributable to differences in the energy spreads of the respective negative ion beams introduced by the sputter generation process.

31725 Some novel design features of the LBL metal vapor vacuum arc ion sources. MacGill, R.A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); Brown, I.G.; Galvin, J.E. *Review of Scientific Instruments (USA)*, 61(1): 580-582 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The family of MEVVA (metal vapor vacuum arc) high current metal ion sources developed at LBL over the past several years has grown to include a number of different source versions with a wide range of some of the design and operational parameters. The MicroMEVVA source is a particularly compact version, about 2 cm diam and 10 cm long, while the MEVVA IV weighs some 30 kG. MEVVAs IV and V incorporate multiple cathode assemblies (16 and 18 separate cathodes, respectively), and the operating cathode can be switched rapidly and without downtime. The new MEVVA V embodiment is quite compact considering its broad beam (10 cm), high voltage (100 kV), and multiple cathode features. The large-area extractor grids used in MEVVA V were fabricated using a particularly simple technique, and they are clamped into position and can thus be changed simply and quickly. The electrical system used to drive the arc is particularly simple and incorporates several attractive features. In this article we review and describe a number of the mechanical and electrical design features that have been developed for these sources.

31726 Charge state distribution studies of the metal vapor vacuum arc ion source. Galvin, J.E. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); Brown, I.G.; MacGill, R.A. *Review of Scientific Instruments (USA)*, 61(1): 583-585 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

We have studied the charge state distribution of the ion beam produced by the MEVVA (metal vapor vacuum arc) high current metal ion source. Beams produced from a wide range of cathode materials have been examined and the charge state distributions have been measured as a function of many operational parameters. In this article we review the charge state data we have accumulated, with particular emphasis on the time history of the distribution throughout the arc current pulse duration. We find that, in general, the spectra remain quite constant throughout most of the beam pulse, as long as the arc current is constant. There is an interesting early-time transient behavior when the arc is first initiated and the arc current is still rising, during which time the ion charge states produced are observed to be significantly higher than during the steady current region that follows.

31727 Focused high-intensity proton beam from a lithium source by using an E×B stigmatic selector. Leal-Quiros, E. (Fusion Research Laboratory, Nuclear Engineering Program, University of Missouri-Columbia, Columbia, Missouri 65211 (US)); Prelas, M.A. *Review of Scientific Instruments (USA)*, 61(1): 636-638 (Jan 1990). DOE Contract FG02-87ER53255. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

This article describes the design and operation of a system that produces a high-intensity proton beam. The system consists of a lithium proton source and an **E×B** stigmatic selector that produces a stigmatic proton beam at the mass focus. The protons are produced by bombarding electrons against a lithium surface. These protons are accelerated toward a special tilted-pole Wien filter (stigmatic selector), which eliminates astigmatism in the proton beam at the mass focus. The stigmatic **E×B** selector was also tested with electron beams, and their astigmatism was also eliminated. A classical **E×B** Wien filter with parallel poles (astigmatic

selector) was used for comparison. The experimental spectral curves of both the proton current and the electron current, each using both types of selectors, are shown.

31728 Nanosecond-length electron pulses from a laser-excited photocathode. Young, A.T. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); D'Etat, B.; Stutzin, G.C.; Leung, K.N.; Kunkel, W.B. *Review of Scientific Instruments (USA)*, 61(1): 650-652 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703--: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A photocathode made from polycrystalline lanthanum hexaboride (LaB_6) has produced nanosecond-length electron pulses when excited by an excimer laser at 308 nm. Peak currents in excess of 1 A have been observed, with quantum yields of 4×10^{-5} being measured. A method for extracting the electrons from an emission-limited cathode, plasma extraction, has been demonstrated. This technique uses a low-power continuous discharge to provide the electric field needed to extract the photoelectrons. This technique may be useful in producing high-repetition-rate short-pulse ion sources.

31729 Alignment effects in Ca-He (5^1P_1–5^3P_J) energy transfer half-collisions. Lin, K.C. (Department of Chemistry, National Taiwan University—Institute of Atomic and Molecular Sciences, Academica Sinica, Taipei 10764, Taiwan (TW)); Ananthamurthy, S.; Kleiber, P.D.; Wang, J.X.; Stwalley, W.C. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 630-633 (20 Oct 1989). Grant NSF-CHE86-15118. (CONF-8810399--: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

We have studied Ca-He spin changing collisions using far wing laser scattering "half-collision" techniques. We have observed a strong red wing-blue wing asymmetry which we interpret in terms of an orbital alignment preference in the energy transfer cross section. This orbital alignment effect approaches 100%.

31730 Statistial spectroscopy: insight or nonsense?. Pique, J. (Department of Chemistry and George R. Harrison Spectroscopy Laboratory, Masachusetts Institute of Technology, Cambridge, MA 02139 (US)); Chen Yongqin; Jonas, D.M.; Lundberg, J.K.; Hamilton, C.E.; Adamson, G.W.; Silbey, R.J.; Field, R.W. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 191(1): 673-682 (20 Oct 1989). DOE Contract FG02-87ER13671. Grant 693/84. (CONF-8810399--: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

Stimulated Emission Pumping (SEP) spectra of acetylene, in an energy region intrinsically unassignable in terms of the usual vibrational quantum numbers, are uniquely suited to decoding by statistical methods such as: averaged square-modulus of the Fourier transform, autocorrelation, and cross-correlation. The key to the utility of statistical measures is that SEP spectra are nearly pure sequences, i.e., each spectrum contains features belonging to only one value of all rigorous quantum numbers. The short-time dynamical information quantum mechanically encoded in the vibrational spectrum is revealed directly by statistical reduction rather than indirectly via the traditional reduction to molecular constants.

31731 Electronic spectroscopy of the ArOH and ArOD complexes. Fawzy, W.M. (Department of Chemistry, Emory University, Atlanta, Georgia 30322 (USA)); Heaven, M.C. *Journal of Chemical Physics (USA)*, 92(2): 909-916 (15 Jan 1990). DOE Contract AC02-76CH00016.

Laser induced fluorescence spectra of the ArOH bands associated with electronic excitation of the OH A–$X(v'=0-v''=0)$ transition were reported previously. An extensive search in the vicinity of the OH/OD $A\,(^2\Sigma^+)$–$X(^2\Pi)$ system ($v'=0-v''=0$) and ($v'=1-v''=0$) led to the observation of 36 vibronic bands which were identified as belonging to ArOH or ArOD complexes. All of the bands were found to originate from the $^2\Pi_{(3/2)}$, $v''=0$ ground electronic state of the OH/OD radical. Two distinguishable vibronic structures were identified. A lower energy vibrational progression was assigned to the van der Waals stretch. This band system was designated as the "*A*" bands. A higher energy set of bands exhibited a different vibrational structure which did not fit a simple vibrational mode progression. These bands were labeled as the "*U*" system. Spectra showing partially resolved rotational structure were recorded for all of the observed ArOH/ArOD bands. The *A* and *U* systems were also distinguished by differences in their rotational structure and effects of H/D substitution on the vibrational and rotational parameters. Preliminary rotational analysis gave ground state constants (B''_0) of 0.100 cm^{-1} for ArOH and 0.098 cm^{-1} for ArOD. (B'_e) constants for the excited state of the *A* system were determined to be 0.178 cm^{-1} for ArOH and 0.168 cm^{-1} for ArOD. These rotational constants show that the Ar–OH/Ar–OD van der Waals bond has been considerably shortened upon electronic excitation.

31732 Quightness: A proposed figure of merit for sources of low-energy, high-charge-state ions. Schmieder, R.W. (Sandia National Laboratories, Livermore, California 94551 (US)). *Review of Scientific Instruments (USA)*, 61(3): 1101-1103 (Mar 1990). DOE Contract AC04-76DP00789.

A variety of ion sources, including the EBIS and ECRIS, are distinguished by their ability to produce low-energy ions of very high charge state. It would be useful to have some figure of merit that is particularly sensitive to this performance. I propose here such a quantity, called "Quightness," which is related to brightness but which enhances the contrast between sources supplying multicharged ions of low energy. The rationale for introducing this quantity, its etymology and relationship to other figures of merit, and some representative values are presented.

31733 Ion optical and beam energy properties of the electron beam ion source. Schmieder, R.W. (Sandia National Laboratories, Livermore, California 94551 (US)). *Review of Scientific Instruments (USA)*, 61(3): 1104-1109 (Mar 1990). DOE Contract AC04-76DP00789.

Various figures of merit describing the performance of ion sources in general are derived for the electron beam ion source (EBIS), which emits ions of very high charge but very low kinetic energy. These relations show the functional dependence of the performance on the experimental source parameters and give values typical of these sources. It is shown that the EBIS is potentially useful not only for injection into accelerators and for atomic physics experiments, but also can supply sufficient energy flux for modification and processing of solid surfaces.

31734 Recoil-ion–projectile-ion–cusp-electron triple-coincidence measurements for 1-MeV/u bare and one-electron O and C projectiles on Ne. Freyou, J. (Department of Physics, University of Tennessee, Knoxville, Tennessee 37996-1200 (US)—Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6377); Breinig, M.; Gaither, C.C. III; Underwood, T.A. *Physical Review, A (General Physics) (USA)*, 41(3): 1315-1323 (1 Feb 1990). DOE Contract AC05-84OR21400.

We have measured in coincidence the projectile-ion charge state, the target-recoil-ion charge state, and the energy of a free electron (cusp electron) emerging from the same collision with a velocity close to the beam velocity, for 1-MeV/u bare and one-electron oxygen and carbon projectiles colliding with neon targets. The most probable recoil-ion charge state of recoil ions not associated with cusp electrons is 1. Most cusp electrons accompany a projectile that does not change charge, and the most probable recoil-ion charge state in this case lies between 2 and 3. The recoil-ion charge-state distribution associated with a cusp electron and bound-state capture by the projectile is shifted towards even higher charge states. Cusp-electron production in conjunction with electron loss by the projectile is not associated with such a large shift. The probability of cusp-electron production given the production of a recoil ion increases with increasing recoil-ion charge state for projectiles that do not change charge and for projectiles that capture an electron, and decreases with increasing recoil-ion charge state for projectiles that lose an electron in the collision.

31735 Electron-loss calculations using the free-collision model. Meron, M. (Department of Applied Science, Brookhaven National Laboratory, Upton, New York 11973 (US)); Johnson, B.M. *Physical Review, A (General Physics) (USA)*, 41(3): 1365-1374 (1 Feb 1990). DOE Contract AC02-76CH00016.

There have been very few measurements of electron-loss cross sections for high-energy (>1-MeV) negative and neutral hydrogen projectiles interacting with gas targets. Previous approaches to the estimation of these cross sections have been based mainly on

semiempirical fits aimed at tying the existing low-energy data to theoretical high-energy Born approximation values. Such target-dependent approaches are reliable only for targets for which a sufficient amount of experimental data exist. The more general approach presented here is based on the free-collision model and uses global properties of the momentum-domain atomic form factor to calculate electron-loss cross sections. The results are simple functions of E and Z, with a small number of target-independent parameters. For each single-electron-loss cross section, $\sigma_{-1,0}$ and $\sigma_{0,1}$, fits to available data are presented.

31736 Measurement of threshold temperature effects in dissociative electron attachment to HI and DI. Chutjian, A. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91109 (US)); Alajajian, S.H.; Man, K. *Physical Review, A (General Physics) (USA),* 41(3): 1311-1314 (1 Feb 1990).

From accurate spectroscopic constants one finds that the thermal dissociative-attachment process (DA) in DI should be exothermic only for rotational levels $J>8$ in $v=0$. We report herein measurement of an enhancement of DA with rotational temperature T in the range 298–468 K. The effect is easily accounted for by the increase in total fractional population of excited J levels in DI relative to HI. The effect affords a *rotational* analog to the use of *vibrationally* excited molecules (e.g., HCl) in a plasma to control electron conduction.

31737 Beam-foil spectroscopy of $n=3$ to $n=2$ transitions in highly stripped bismuth. Dietrich, D.D. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)); Simionovici, A.; Chen, M.H.; Chandler, G.; Hailey, C.J.; Egan, P.O.; Mokler, P.H.; Reusch, S.; Hoffmann, D.H.H. *Physical Review, A (General Physics) (USA),* 41(3): 1450-1456 (1 Feb 1990). DOE Contract W-7405-ENG-48.

The $n=3$ to 2 transitions in Ne-like, Na-like, and Mg-like bismuth were measured on the UNILAC accelerator at the Gesellschaft fuer Schwerionenforschung in Darmstadt, West Germany, using the Lawrence Livermore National Laboratory high-resolution double-crystal spectrometer. The measurements cover the region 10–14 keV with precisions of the order of 100 ppm and include electric-dipole and quadrupole transitions. Theoretical multiconfigurational Dirac-Fock calculations were made for the Ne-like system and compared to the experiment. The data exhibit energy shifts of 1.5–2.5 eV from the theory, confirming trends previously observed in tokamak experiments. The Na-like and Mg-like results are compared with unresolved transition array calculations.

31738 Phase space bifurcation structure and the generalized local-to-normal transition in resonantly coupled vibrations. Li, Z. (Department of Chemistry, Northeastern University, Boston, Massachusetts 02115 (US)); Xiao, L.; Kellman, M.E. *Journal of Chemical Physics (USA),* 92(4): 2251-2268 (15 Feb 1990). DOE Contract W-31109-ENG-38.

The generalization of the local-to-normal transition seen in symmetric triatomics is considered for nonsymmetric molecules and 2:1 Fermi resonance systems. A straightforward generalization based on a division of phase space into local and normal regions is not possible. Instead, classification of the *phase space bifurcation structure* is presented as the complete generalization of the local–normal concept for all spectroscopically relevant systems of two vibrations interacting via a single nonlinear resonance. The polyad phase sphere (PPS) is shown to be the natural arena to analyze the bifurcation structure for resonances of arbitrary order. For 1:1 and 2:1 resonances, the bifurcation problem is reduced to one or two great circles on the phase sphere. All bifurcations are shown to be examples of elementary bifurcations of vector fields in one dimension. The classification of the bifurcation structure is therefore governed and greatly simplified by the theory of the universal unfolding and codimension of elementary bifurcations. The implications for large-scale bifurcation structure and transport in molecules with chaotic motion are briefly discussed.

31739 Antiproton storage materials: Response of neon, argon, and benzene to a negative particle. Cahill, P.A. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)); Anderson, R.A.; Riley, M.E. *Physical Review, A (General Physics) (USA),* 41(5): 2315-2321 (1 Mar 1990). DOE Contract AC04-76DP00789.

The energies of systems composed of a point negative charge (e.g., antiproton, $\bar{p}$, or negative muon, μ^-) and an atom or small molecule (He,Ne,Ar,C_6H_6) have been calculated using large-basis-set, correlated *ab initio* electronic-structure methods. By invoking the Born-Oppenheimer approximation, these energies are used to generate potential surfaces for the interaction of a negative particle with an atom or small molecule. The results indicate that the particle-induced polarizations are significant even at 10-bohr separations in neon. Unusual behavior of the dipole moments of both argon and neon was calculated to occur as a function of separation. The molecular-orbital approach used here may also be useful in analyzing recent ionization behavior in low-energy $\bar{p}$–inert-gas scattering experiments. Furthermore, the calculated large degree of polarization further constrains the design of materials for long-term normal matter storage of antiprotons for advanced energy sources.

31740 Electron scattering in dense atomic and molecular gases: An empirical correlation of polarizability and electron scattering length. Rupnik, K. (Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana 70803 (US)); Asaf, U.; McGlynn, S.P. *Journal of Chemical Physics (USA),* 92(4): 2303-2304 (15 Feb 1990).

A linear correlation exists between the electron scattering length, as measured by a pressure shift method, and the polarizabilities for He, Ne, Ar, Kr, and Xe gases. The correlative algorithm has excellent predictive capability for the electron scattering lengths of mixtures of rare gases, simple molecular gases such as H_2 and N_2 and even complex molecular entities such as methane, CH_4.

31741 Low-energy positron-argon collisions by using parameter-free positron correlation polarization potentials. Jain, A. (Department of Physics, Box 981, Florida A&M University, Tallahassee, Florida 32307 (US)). *Physical Review, A (General Physics) (USA),* 41(5): 2437-2444 (1 Mar 1990). DOE Contract FC05-85ER25000.

We report differential, integral, and momentum-transfer cross sections and the scattering length (A_0) for positron (e^+)-argon scattering at low energies below the positronium formation threshold. An optical-potential approach is employed in which the repulsive Coulombic interaction is calculated exactly at the Hartree-Fock level and the attractive polarization and correlation effects are included approximately via a parameter-free positron correlation polarization (PCP) potential recently proposed by us. The PCP model is based on the correlation energy ε_{corr} of one positron in a homogeneous electron gas; in the outside region, the ε_{corr} is joined smoothly with the correct asymptotic form of the polarization interaction ($-\alpha_0/2r^4$, where α_0 is the target polarizability) where they cross each other for the first time. The total optical potential of the e^+-argon system is treated exactly in a partial-wave analysis to extract the scattering parameters. It is found that the PCP potential gives much better qualitative results, particularly for the differential cross sections and the scattering length, than the corresponding results obtained from an electron polarization potential used as such for the positron case. We also discuss the "critical" points (representing the minima in the differential scattering) in the low-energy e^+-Ar scattering. The present results involve no fitting procedure.

31742 Hyperfine structure of lanthanum at sub-Doppler resolution by diode-laser-initiated resonance-ionization mass spectroscopy. Shaw, R.W. (Analytical Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6142 (US)); Young, J.P.; Smith, D.H.; Bonanno, A.S.; Dale, J.M. *Physical Review, A (General Physics) (USA),* 41(5): 2566-2573 (1 Mar 1990). DOE Contract AC05-84OR21400.

Hyperfine structures of atomic lanthanum at sub-Doppler resolution have been recorded using diode-laser-initiated resonance-ionization and mass-spectrometric detection. Spectra were recorded for two diode-laser-pumped transitions, $^2D_{3/2}$-$^4F^0_{3/2}$ and $^2D_{5/2}$-$^4F^0_{3/2}$, at 753.9 and 819.0 nm, respectively. The linewidths observed were as narrow as 165 MHz, substantially below the expected Doppler width of 1 GHz for the 1700-K sample. Atomic hyperfine structure constants for the 13 13260-cm^{-1} $^4F^0_{3/2}$ state were determined from the spectra: $A=-350\pm4$ MHz and

B=54±12 MHz. Isotopically selective resonance ionization was achieved, even though a broadband dye laser was involved in the overall ionization process.

31743 Rotationally inelastic gas–surface scattering: HCl from Au(111). Lykke, K.R. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)); Kay, B.D. *Journal of Chemical Physics (USA)*, 92(4): 2614-2623 (15 Feb 1990). DOE Contract AC04-76DP00789.

A quantum-resolved molecular beam–surface scattering study of HCl scattered from Au(111) is described. The HCl is detected in a quantum-resolved manner via (2+1) resonant enhanced multiphoton ionization (REMPI). Greater than 85% of the incident HCl molecules are in a single-quantum state (v=0, J=0) with a narrow velocity distribution ($\Delta v/v<0.10$). The scattered HCl is strongly peaked about the specular angle, and both its final velocity and rotational distributions are indicative of direct inelastic scattering. The scattered rotational distributions exhibit features characteristic of rotational rainbows and have a mean rotational energy that displays a bilinear dependence upon the incident normal kinetic energy and surface temperature. The final velocity distributions are largely insensitive to the rotational level and indicate that the energy loss to phonons is small (<20%). Analysis of the scattered data indicates an orientation-averaged attractive well depth of ~5 kcal/mol for the HCl–Au(111) interaction.

31744 Kinetics of hydrogen adsorption and absorption: Catalytic gate MIS gas sensors on silicon. . Hughes, R.C. (Sandia National Labs, Albuquerque, NM (US)); Taylor, P.A.; Ricco, A.J.; Rye, R.R. *Journal of the Electrochemical Society (USA)*, 136(9): 2653-2660 (Sep 1989). DOE Contract AC04-76DP00789.

Silicon diodes employing Pd as a contact (gate) on top of a thin intervening SiO_2 layer on Si make sensitive detectors for molecular hydrogen. The response to hydrogen results from the population of Pd/SiO_2 interfacial traps for atomic H. Response time is of the order of minutes of 30°C for 100 ppm of H_2, through the speed of response can be increased by orders of magnitude by sputter cleaning the Pd in ultrahigh vacuum (UHV). Two aspects of the problem of contamination by exposure to the atmosphere are reported: the time dependence of the loss of activity of a cleaned diode after removal from UHV, and the response characteristics of a contaminated diode. Comparison is made between the rates of filling and emptying of the interfacial traps, as measured by the diode signal, with the rate of filling and emptying of the bulk, as measured by the resistance of the Pd. A model based on quasi-equilibrium between H in the Pd bulk and at the Pd/SiO_2 interface is proposed, and it is concluded that, for diodes with a contaminated Pd surface, the bulk and interface are in equilibrium throughout the filling and emptying processes, with adsorption and desorption being the rate-limiting steps.

6404 Fluid Physics

Refer also to citation(s) 30938, 30940, 30950, 30970, 31688, 31912

31745 (CICS–CE02997, pp. 119-124) **Numerical and experimental investigation of the complex flowfield in an annular reverse-flow conbustor.** Hu, J.T.C. (Toronto Univ., Downsview, ON (Canada)); Cusworth, R.A.; Sislian, J.P. Combustion Inst. (Canada). Canadian Section. [1990]. (CONF-8705158–: ; CE–02997). In *The Combustion Institute, Canadian Section, 1987 Spring technical meeting.* Available from Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST.

The objectives of the present investigation were: to develop a 2-dimensional computer code based on TEACH (an already existing computational fluid dynamics program) to study steady, turbulent, axisymmetric, recirculating, confined, compressible and combusting flow; and to obtain laser doppler velocimetry (LDV) measurements of the 2 mean velocity components and of the corresponding turbulence intersities in the flow demain of a Pratt and Whitney annular reverse-flow combustor, measurements which will serve as a benchmark case for this and future computer codes. This paper covers the first part of the investigation, which is concerned with the cold flow in the combustor, that is, without the complications of fuel injection and combustion. The sector-shaped apparatus is described. The preliminary laser visualization of the flow seeded with 20mm glass beads is presented. The geometry of the combustor is represented by a stair-step boundary, and the flow field is covered by a uniform or non-uniform rectangular grid pattern. The computer code developed is based on the steady, time-averaged, elliptic form of the Reynolds formulation of the Navier Stokes equations, turbulence being simulated by a 2 eauation k-E model. The results of the calcualtion, which show 3 recirculating flow zones, are presented. The 2-component LDV measurement system, based on the scattering of 0.488 and 0.5145mm light by sub-micronic particles, and the micro-computer-based data acquisition system, are described. The results of these measurements show that the present computer code provides a qualitatively accurate description of the cold flow field. In the second phase of this investigation, the code will be modified to incorporate combustion; preliminary results obtained with the present version of the code and with inlet temperature of between 800 and 1000°K are presented. 7 refs., 3 figs.

31746 (CONF-900188–1) **Flow fields inside MHD generators and seawater thrusters.** Doss, E.D. (Argonne National Lab., IL (USA)); Roy, G.D. Argonne National Lab., IL (USA). [1990]. 11p. Sponsored by U.S. Department of Defense. DOE Contract AC04-76DP00789. From 3. international congress of fluid mechanics; Cairo (Egypt); 2-4 Jan 1990. Order Number DE90010475. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The three-dimensional flow characteristics inside MHD plasma generators and seawater thrusters are analyzed by solving the governing partial differential equations for flow and electrical fields. The equation set consists of the mass continuity equation, the three momentum equations, the equations for enthalpy, turbulence kinetic energy and its dissipation rate, and the Maxwell equations. This set of coupled equations is solved by the use of a finite-difference calculation procedure. The turbulence is represented by a two-equation model of turbulence in which partial differential equations are solved for the turbulence kinetic energy and its dissipation rate. Calculations have been performed for a Faraday plasma generator and for a continuous electrode seawater thruster. The numerical results of those two applications are compared. Calculations have been made to study the flow evolution in MHD generators and thrusters. The calculations show that the velocity overshoots and secondary flows are strongly manifested in MHD generators but not so in MHD thrusters. Plots of velocity and skin friction are presented to illustrate the flow development in MHD generators and thrusters. 9 refs., 3 figs.

31747 (DOE/ER/13916–T2) **[The physics of cellular automata and coherence and chaos in classical, many-body dynamical systems]: Progress report, March 1989–Present.** Ohio State Univ. Research Foundation, Columbus, OH (USA). 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13916. Order Number DE90010627. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following: Saffman-Taylor type instabilities; Hele-Shaw bubble motion; cylinder wake; behavior of coupled lattice maps with a conservation law; non-ergodic behavior in locally interacting continuous systems; study of models that exhibit self-organized critical behavior; and new method for the characterization of unstable periodic orbits. (LSP)

6450 High Energy Physics

31748 (SLAC–343, pp. 42-47) **Perspective on tau studies at a tau-charm factory.** Burchat, P.R. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A high luminosity storage ring operating at center-of-mass energies in the range 3-5 GeV would allow high-statistics studies of the

τ lepton. To take full advantage of the large data samples, the systematic errors must be greatly reduced compared to those for existing τ measurements. The size of uncertainties on current measurements and the desired precision of future measurements of τ properties are discussed. A τ physics program at a τ-charm factory is outlined and briefly compared to that at a B$\bar{B}$ factor.

31749 (SLAC–343, pp. 48-89) **Beautiful τ physics in the Charm Land.** Gomez-Cadenas, J.J. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The proposed τ-Charm Factory combines several unique features that will make possible to perform very beautiful τ experiments. The authors discusses here three examples. The limits on the ν_τ mass, where a sensitivity of the order of 3 MeV can be achieved. The measurement of the one-charged prong branching fractions, to a fractional error of 0.5-1%. And the study of the Michel parameters, where precisions comparable to the μ decay experiments can be reached.

31750 (SLAC–343, pp. 152-168) **D^0-$\bar{D}^0$ mixing and CP violation: Experimental projections for a τ-charm factory.** Gladding, G. (Univ. of Illinois, Urbana (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC02-76ER01195. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

This report presents the results of a set of feasibility studies for observing D^0 - $\bar{D}^0$ mixing and CP violation in the proposed high luminosity τ-charm factory. These studies are not yet complete, but clear general conclusions can already be drawn. In particular, a year of running with 10^{33} luminosity would allow observation of D^0 - $\bar{D}^0$ mixing at the level of 10^{-4} to 10^{-5}, consistent with standard model expectations, while CP violation in the D system could be probed at the 10^{-2} level.

31751 (SLAC–343, pp. 220-230) **Exotic hadrons and hadron dynamics at a tau-charm factory.** Close, F.E. (Oak Ridge National Lab., TN (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC05-84OR21400. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Prospects for identifying hybrids and glueballs in ψ decays are summarized.

31752 (SLAC–343, pp. 330-341) **Vertical separation for TCF.** Donald, M.; Garren, A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors studied an insertion for electrostatic separation of the electron and positron beams with the aims of: increasing luminosity by decreasing the minimum bunch spacing, matching the vertical dispersion function (not done in the Jowett lattice). The authors looked at three possibilities for the start of the insertion: a quadrupole doublet followed by the electrostatic separator (Jowett), a quadrupole doublet with the electrostatic separator between the two quadrupoles (Kamada), a separator followed by a quadrupole doublet. The third possibility was immediately discharged. Although possible for a B-factor with magnetic separation it is impractical for use with electrostatic separation because of the length and cross section of separator required. The Kamada scheme looked promising for getting very short inter-bunch spacing, but suffered from the disadvantage of requiring a very large ratio of beta functions at the Interaction Point (IP) ($\beta_x^*/\beta_y^* = 100$). (They would rather have a β^* ratio closer to 20 to 1). They decided to persue the doublet scheme to see whether it could match the performance of Kamada insertion. They assumed superconducting magnets could be used for the insertion quadrupoles, and they used as strong an electrostatic field for the separator as Kamada.

31753 (SLAC–343, pp. 408-415) **Applying QCD to inclusive decay rates of the τ lepton.** Braaten, E. (Northwestern Univ., Evanston, IL (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The application of QCD to the inclusive semihadronic decay rates of the τ are described. It is argued that the QCD corrections, both perturbative and nonperturbative, can be systematically calculated within the framework of the short-distance expansion. Phenomenological evidence is presented that indicates that M_τ is safely within the region of validity of the QCD predictions.

31754 (SLAC–343, pp. 416-435) **QCD tests from tau-decay data.** Pich, A. (Universitat de Valencia, Burjassot (Spain)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The semileptonic tau-decay provides useful information on the algebra of currents of QCD. It is shown how good experimental data on the decay modes of the tau lepton, can be used for testing fundamental aspects of the strong interactions (chiral symmetry, resonance structures, vacuum condensates, empty set MS, ···).

31755 (SLAC–343, pp. 576-588) **Physics with low-energy e^+e^- and e^-e^- collisions at Tau-Charm Factory.** Gan, K.K. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The physics opportunities in e^+e^- collisions with $\sqrt{s} \simeq$ 1-2 GeV and e^-e^- collisions with $\sqrt{s} \sim 5$ GeV at Tau-Charm Factory are being explored. The low-energy e^+e^- option allows precise measurements of e^+e^- cross sections into π and η and hence stringent tests of the conserved-vector-current (CVC) hypothesis in τ decays. Precise measurements of the total hadronic cross section also permits a more precise calculation of the muon anomalous magnetic moment (g-2). The e^-e^- option provides an opportunity for a sensitive search for lepton-number violating processes $e^-e^- \rightarrow \mu^-\mu^-$, $\tau^-\tau^-$, $\mu^-\tau^-\cdots$ The e^-e^- collider also provides an ideal laboratory for two-photon physics with no one-photon background and the direct measurement of the two-photon background in one-photon physics.

31756 (SLAC–343, pp. 909-910) **Λ_c + tagging at a tau-charm factory.** Klein, S.R. (Boston Univ., MA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The cross section for charmed quark production in $e + e^-$ annihilation is given by: σ = 86.8 nb (2/3) $2/E_{cm}$ 2(GeV). At 4.6 GeV, just above the $\Lambda_c\bar{\Lambda}_c$ production threshold, the cross section is 1.8

nb. At a luminosity of 10 33 cm−2 sec−1, the production rate is 1.8 Hz, or 36 million pairs per 2 x 10 7 second year. According to the tradditional quark-diquark fragmentation picture, roughly 10% of these will turn into $\Lambda_c\bar{\Lambda}_c$ pairs. The Mark II at SPEAR measured a higher percentage, 20%, but he will use the lower rate. With it, 4 million $\Lambda_c\bar{\Lambda}_c$ pairs will be produced each year. The tagging efficiency will depend on the number of modes tagged, and the reconstruction efficiency.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 31064, 31754, 31827

31757 (ANL-HEP-CP-89-120) **Experimental tests of proton spin models.** Ramsey, G.P. (Loyola Univ., New Orleans, LA (USA). Dept. of Physics). Argonne National Lab., IL (USA). High Energy Physics Div. 3 Nov 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-8910121–4: 6. topical conference on physics with polarized beams on polarized targets, Spencer, IN (USA), 16-18 Oct 1989). Order Number DE90010545. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have developed models for the spin-weighted quark and gluon distribution in a longitudinally polarized proton. The model parameters are determined from current algebra sum rules and polarized deep-inelastic scattering data. A number of different scenarios are presented for the fraction of spin carried the constituent parton distributions. A possible long-range experimental program is suggested for measuring various hard scattering processes using polarized lepton and proton beams. With the knowledge gained from these experiments, we can begin to understand the parton contributions to the proton spin. 28 refs., 5 figs.

31758 (BNL–44452) **First observation of Λ^0,$\bar{\Lambda}^0$,K_s^0 production in relativistic heavy ion collisions at the AGS [Alternating Gradient Synchrotron].** Hallman, T. (Johns Hopkins Univ., Baltimore, MD (USA)); Madansky, L.; Welsh, R.; Bonner, B.E.; Krishna, N.; Kruk, J.; Mutchler, G.S.; Nessi, M.; Nessi-Tedaldi, F.; Tonse, S. Brookhaven National Lab., Upton, NY (USA). 30 Mar 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AC02-83ER40107;AS05-81ER40032;AC02-(CONF-900331–4: Workshop on heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 3-7 Mar 1990). Order Number DE90010121. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We report here the first observation of inclusive Λ^0, $\bar{\Lambda}^0$, K_s^0 production in nucleus-nucleus collisions at 14.5 GeV/n. 11 refs., 6 figs.

31759 (BNL–44520) **Production of rare composite objects in relativistic heavy ion collisions.** Dover, C.B. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900331–6: Workshop on heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 3-7 Mar 1990). Order Number DE90010646. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We discuss the production of antimatter, multiply strange objects and stable multiquark systems containing both strange and charmed quarks ($\bar{c}suud$). The possibilities for studies of charm production at RHIC energies are probed. 61 refs., 4 figs., 3 tabs.

31760 (DESY-F31–89-04) **Determination of the $\gamma\gamma$ partial width of the η meson and search for other states in $\gamma\gamma \to \pi^0\pi^0\pi^0$.** Sievers, D. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Physik. Dec 1989. 86p. (In German). Available from Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.).

The Crystal Ball detector has been used to measure the exclusive production of $\pi^0\pi^0\pi^0$ final states in the collision of two quasireal photons. The data, corresponding to an integrated luminosity of 99/pb, were taken at the e^+e^--storage ring DORIS II between 1983 and 1986. The observed $\pi^0\pi^0\pi^0$ invariant mass spectrum shows a prominent signal at the η-mass and only few events at higher invariant masses. The number of observed η-mesons has been used to determine the two-photon partial width of the η. The result $\Gamma_{\gamma\gamma}(\eta) = (0.488 \pm 0.034 \pm 0.065)$ keV is in good agreement with other measurements obtained at e^+e^--storage rings. The $\pi^0\pi^0\pi^0$ invariant mass spectrum shows no other resonant structure, therefore we calculated upper limits on the product $\Gamma_{\gamma\gamma}(X) \times B(X \to \pi^0\pi^0\pi^0)$ for pseudoscalar resonances X. These upper limits are ranging from < or approx. 0.01 keV (for $m_X \simeq 800$ MeV/c^2) up to < or approx.1 keV (for $m_X \simeq 2000$ MeV/c^2). (orig.).

31761 (DOE/ER/40315–172) **Progress in hyperon production at LEAR [Low-Energy Antiproton Ring].** Frankenberg, R. von (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik). Carnegie-Mellon Univ., Pittsburgh, PA (USA). 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40315. Order Number DE90010520. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The studies of hyperon reactions with antiprotons close to threshold offer an excellent opportunity to examine the dynamics of strangeness creation. At the LEAR facility at CERN, the PS185 Collaboration has initiated a set of measurements of the process $\bar{p}p \to \bar{\Lambda}\Lambda$ between the reaction threshold and excess energies of 170 MeV. Above an antiproton momentum of 1.65 GeV/c the reaction $\bar{p}p \to \bar{\Lambda}\Sigma^0$ + c.c. offers the possibility of studying the isospin structure in strangeness exchange (I = J = 0 for the Λ and I = J = 1 for the Σ^0). For the charged $\bar{\Sigma}\Sigma$ channels (Σ^+ and Σ^-), no data exist in the accessible range of LEAR, which corresponds to the region close to threshold. A dedicated run of experiment PS185 to measure the reactions $\bar{p}p \to \bar{\Sigma}^+\Sigma^+$ and $\bar{p}p \to \bar{\Sigma}^-\Sigma^-$ is in preparation. 19 refs., 5 figs.

31762 (DOE/ER/40315–173) **A search for the ξ(2230) resonance in the $\bar{p}$ p $\to K_sK_s$ channel at LEAR [Low Energy Antiproton Ring].** Seydoux, J. PS185 collaboration. Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics. Feb 1990. 101p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER40315. Order Number DE90010126. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

Seventeen measurements of differential and total cross sections of the $\bar{p}p \to K_sK_s$ reaction in the antiproton momentum range of 1.30 GeV/c to 1.57 GeV/c are presented. Most of these measurements are centered around the mass of the ξ(2230) resonance first seen in the K^+K^- and K_sK_s channel of the radiative decay of the J/Ψ by the MARK III collaboration at SLAC. The trajectories of the charged decay products of the K_s particles are recorded by two stacks of drift chambers and a set of plastic streamer tube planes. The $\bar{p}p \to K_sK_s \to \pi^+\pi^-\pi^+\pi^-$ events are reconstructed by a computer program and undergo a full kinematic fitting. A branching ratio upper limit, $BR(\bar{p}p \to \xi) \cdot BR(\xi \to K_sK_s)$, on the presence of the resonance is calculated. The experiment was performed by the PS185 collaboration at the Low Energy Antiproton Ring (LEAR) at CERN.

31763 (FNAL/C–90/32-E) **The dijet invariant mass at the Tevatron Collider.** The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8909291–7: 8. topical workshop on proton-antiproton collider physics, Castiglione della Pescaia (Italy), 1-5 Sep 1989). Order Number DE90010526. Available from NTIS, PC A03/MF A01; OSTI; INIS.

The differential cross section as a function of the dijet invariant mass has been measured in 1.8 TeV ppbar collisions. A comparison to leading order QCD predictions is presented as well as a study of the sensitivity of the mass spectrum to the gluon radiation. The need to take radiation into account requires the study of its spatial distribution and the comparison of the data to the predictions of shower Monte Carlo programs like Isajet and Herwig. 12 refs., 10 figs.

31764 (FNAL/C–90/33-E) **Asymmetry in Z^0 decay at CDF.** The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8909291–8: 8. topical workshop on proton-antiproton collider physics, Castiglione della Pescaia (Italy), 1-5 Sep 1989). Order Number DE90010527. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

An analysis of the charge asymmetry in $p\bar{p} \rightarrow Z^0 \rightarrow e^+e^-$ events at CDF yields the preliminary value $\sin^2 \theta_w = 0.216 \pm 0.015$ (stat) ± 0.010 (sys). 3 figs.

31765 (GSI-90-03(prepr.)) **Search for long-lived neutral resonances in Bhabha scattering around 1.8 MeV/c^2.** Judge, S.M. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France). Centre de Tri); Krusche, B.; Schreckenbach, K.; Tsertos, H.; Kienle, P. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Jan 1990. 16p. Order Number DE90784836. Available from NTIS (US Sales Only), PC A03/MF A01.

A search has been carried out for long-lived neutral particles, which could be created in resonant e^+e^- scattering, with an invariant mass around 1.8 MeV/c^2. A monoenergetic positron beam was scattered from a thin Be foil, and an active-shadow technique was used to suppress elastic e^+e^- scattering. No evidence was found for neutral resonances with a lifetime between 4.5×10^{-13} and 7.5×10^{-12} s (95% C.L. in the unitarian limit). The lifetimes τ^* for possible new neutral particles, which decay dominantly into e^+e^- pairs, are thus limited to the small range: $7.5 \times 10^{-12} < \tau^* \leq 10^{-10}$ s. (orig.).

31766 (LA-UR-90-1242) **Possibilities for a neutron-proton bremsstrahlung experiment at WNR/LAMPF [Los Alamos Meson Physics Facility].** Wender, S.A.; Nelson, R.O.; Laymon, C.M.; Schillaci, M.; Gibson, B.F. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900179-2: Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung, Los Alamos, NM (USA), 25-26 Jan 1990). Order Number DE90010571. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The high energy and high intensity of the continuous energy (white) neutron source at the WNR target area of the Los alamos Meson Physics Facility (LAMPF) may make possible a direct measurement of the neutron-proton bremsstrahlung (NPB) cross section. Several recent papers have discussed the operation of the WNR white neutron source in detail so we will just include a short description of the relevant properties of the source in this article. Next we will describe one possible method of measuring the NPB cross section which is based on two calorimetric detectors that measure the energies of the scattered neutrons and the recoil protons. There are several advantages in using a white neutron source for this type of measurement. First, a wide range of incident neutron energies may be covered. In the case of the WNR, the energy range is from below 50 MeV to over 400 MeV which is above the pion production threshold. Second, all incident neutron energies are measured simultaneously. The greatly reduces the systematic errors associated with sequential measurements at different beam energies when measuring the energy dependence of the NPB cross section. Third, the neutron beam is shared amongst several experimenters at WNR. This greatly reduces the competition for beam time, so longer runs are often possible compared to facilities that require the dedicated use of the accelerator. In the past, typical experiments have run for several months. 6 refs., 5 figs.

31767 (MPI-PAE/Exp.El.-220) **Measurement of the masses and lifetimes of the charmed mesons D^0, D^+ and D_S^+.** Barlag, S.; Becker, H.; Bosman, M.; Dietl, H.; Klanner, R.; Luecking, B.; Luetjens, G.; Lutz, G.; Maenner, W.; Neugebauer, E. ACCMOR Collaboration. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Jan 1990. 15p. Available from Also published in Z. Phys., C (May 1990) v. 46(4) p. 563-567.

We present the final results on the measurement of the masses and lifetimes of the mesons D^0, D^+ and D_S^+ in the NA32 experiment at the CERN SPS, using silicon microstrip detectors and charge-coupled devices for vertex reconstruction. We measure the following lieftimes: $\tau sub(D^0) = 3.88 \pm_{0.21}{}^{0-.23} \times 10^{-13}$s using a sample of 479 $D^0 \rightarrow K^-\pi^+\pi^-\pi^+$ and 162 $D^0 \rightarrow K^-\pi^+$ decays; $\tau sub(D^+) = 10.5 \pm_{0.72}{}^{0-.23} \times 10^{-13}$s with a sample of 317 $D^+ \rightarrow K^-\pi^+\pi^+$ decays; $\tau sub(D_S{}^4) = 4.69 \pm_{0.86}{}^{1-.02} \times 10^{-13}$ s with a sample of 54 $D_S^+ \rightarrow K^+K^-\pi^+$ decays. We measure the following masses: $msub(^0) = 1864.6 \pm 0.3 \pm 1.0$ MeV, $msub(D^+) = 1870.0 \pm 0.5 \pm 1.0$ MeV and $msub(D_S^+) = 1967.0 \pm 1.0 \pm 1.0$ MeV. (orig.).

31768 (MPI-PAE/Exp.El.-221) **Investigation of intermittency in muon-proton scattering at 280 GeV.** Derado, I. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.)); Jancso, G.; Schmitz, N.; Stopa, P. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Feb 1990. 22p. Order Number DE90785075. Available from NTIS (US Sales Only), PC A03/MF A01.

In this paper intermittency is investigated in hadron production by muon proton interactions at 280 GeV, using data of the European Muon Collaboration. Intermittent behaviour is observed in the dependence of the scaled factorial moments on the rapidity bin width. This behaviour is stronger for positive than for all charged hadrons; it increases with the hadronic cms energy W, and is larger in the central region than in the fragmentation regions. The data are compared with the predictions of the Webber model, the Lund model, and of short-range ordering. (orig.).

31769 (SLAC-PUB-5202) **Status of the Tau-Charm Facility and highlights of its physics program.** Schindler, R.H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-9002118-1: 1990 Lake Louise winter institute: the standards model and beyond, Lake Louise (Canada), 18-24 Feb 1990). Order Number DE90010177. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper I will first discuss the history and current status of the Tau-Charm Facility. I will then focus on the unique aspects of the heavy meson and tau physics program of such a facility, which motivates its construction and operation in the mid-1090's.

31770 New method to detect a heavy top quark at the Fermilab Tevatron. Yuan, C. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)). *Physical Review, D (Particles Fields) (USA),* 41(1): 42-51 (1 Jan 1990). DOE Contract W-31109-ENG-38.

We present a new method to detect a heavy top quark with mass ~180 GeV at the upgraded Fermilab Tevatron ($\sqrt{S}$ =2 TeV and integrated luminosity 100 pb^{-1}) and the Superconducting Super Collider (SSC) via the *W*-gluon fusion process. We show that an almost perfect efficiency for the "kinematic *b* tagging" can be achieved due to the characteristic features of the transverse momentum P_T and rapidity *Y* distributions of the spectator quark which emitted the virtual *W*. Hence, we can reconstruct the invariant mass $M^{\mu\nu b}$ and see a sharp peak within a 5-GeV-wide bin of the $M^{\mu\nu b}$ distribution. We conclude that more than one year of running is needed to detect a 180-GeV top quark at the upgraded Tevatron via the *W*-gluon fusion process. Its detection becomes easier at the SSC due to a larger event rate.

31771 Upper limit on the absolute branching fraction for $D_s^+ \rightarrow \phi\pi^+$. Adler, J.; Bai, Z.; Blaylock, G.T.; Bolton, T.; Brient, J.; Browder, T.E.; Brown, J.S.; Bunnell, K.O.; Burchell, M.; Burnett, T.H. Mark III Collaboration. *Physical Review Letters (USA),* 64(2): 169-171 (8 Jan 1990). DOE Contract AA03-76SF00034.

We report a study of the hadronic branching fractions of the D_s^+ meson, which is used to extract an upper limit on the absolute branching fraction for $D_s^+ \rightarrow \phi\pi^+$. A search is made for fully reconstructed events from the reaction $e^+e^- \rightarrow D_s^{*\pm} D_s^{\mp}$, $D_s^{*\pm} \rightarrow \gamma D_s^{\pm}$, using seven exclusive D_s^+ decay modes. The data sample of 6.30 ± 0.46 pb^{-1} was collected at $\sqrt{s}$=4.14 GeV with the Mark III detector at the SLAC e^+e- storage ring SPEAR. No candidate events are observed. The measured relative D_s^+ branching fractions and $\sigma B(D_s^+ \rightarrow \phi\pi^+)$ are used to establish the limit $B(D_s^+ \rightarrow \phi\pi^+) < 4.1\%$ at 90% confidence level.

31772 Search for the top quark in the reaction $\bar{p}p \rightarrow$electron+jets at $\sqrt{s}$ =1.8 TeV. Abe, F.; Amidei, D.; Apollinari, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Bamberger, A.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review Letters (USA),* 64(2): 142-146 (8 Jan 1990).

A search for the top quark in $\bar{p}p$ collisions at a center-of-mass energy of 1.8 TeV using the Collider Detector at Fermilab is described. A study of events selected by requiring an energetic electron, missing transverse energy, and two or more jets excludes at 95% confidence level the standard-model production and decay of $t\bar{t}$ pairs if the top-quark mass is between 40 and 77 GeV/c^2. The

observed electron + multijet data are consistent with *W*-boson production.

31773 Search for new heavy quarks in electron-muon events at the Fermilab Tevatron Collider. Abe, F.; Amidei, D.; Apollinari, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Bamberger, A.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review Letters (USA)*, 64(2): 147-151 (8 Jan 1990).

A search for $t\bar{t}\rightarrow e\mu+X$ in $p\bar{p}$ collisions at $s\bar{\sqrt{}}$ TeV is described. The production and decay of top-quark–antiquark pairs is considered in the context of the standard model. The analysis is based on data with an integrated luminosity of 4.4 pb^{-1} recorded with the Collider Detector at Fermilab. An upper limit on the $t\bar{t}$ cross section is obtained, and the top quark in the mass range 28–72 GeV/c^2 is excluded at the 95% C.L. The same limits apply to a possible fourth-generation, charge −1/3, *b'* quark, decaying via the charged current.

31774 Measurement of the ratio $\sigma(W\rightarrow e\nu)/\sigma(Z\rightarrow ee)$ in $\bar{p}p$ collisions at $\sqrt{s}$ =1.8 TeV. Abe, F.; Amidei, D.; Apollinari, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Bamberger, A.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review Letters (USA)*, 64(2): 152-156 (8 Jan 1990).

An analysis of *W*- and *Z*-boson production using data from the Collider Detector at Fermilab at $\sqrt{s}$ =1.8 TeV yields $\sigma(W\rightarrow e\nu)/\sigma(Z\rightarrow ee)=10.2\pm0.8(\text{stat})\pm0.4(\text{syst})$. The width of the *W* boson, $\Gamma(W)$, and a limit on the top-quark mass independent of decay mode are extracted from this measurement.

31775 Two-jet differential cross section in $p\bar{p}$ collisions at $\sqrt{s}$1.8 TeV. Abe, F.; Amidei, D.; Apollinari, G.; Ascoli, G.; Atac, M.; Auchincloss, P.; Baden, A.R.; Barbaro-Galtieri, A.; Barnes, V.E.; Bedeschi, F. *Physical Review Letters (USA)*, 64(2): 157-160 (8 Jan 1990).

The two-jet differential cross section $d^3\sigma(\bar{p}p\rightarrow\text{jet 1+jet 2+}X)/dE_{\text{jet}}d\eta_1 d\eta_2$, averaged over $-0.6\leq\eta_1\leq0.6$, at $\sqrt{s}$ =1.8 TeV, has been measured in the Collider Detector at Fermilab. The predictions of leading-order quantum chromodynamics for most choices of structure functions show agreement with the data.

31776 Measurement of the analyzing power in the Primakoff process with a high-energy polarized proton beam. Carey, D.C.; Coleman, R.N.; Corcoran, M.D.; Cossairt, J.D.; Derevschikov, A.A.; Grosnick, D.P.; Hill, D.; Imai, K.; Konaka, A.; Kuroda, K. *Physical Review Letters (USA)*, 64(4): 357-360 (22 Jan 1990). DOE Contract W-31109-ENG-38;AC02-76CH03000;AC02-76ER02289;W-740

The analyzing power (spin-dependent azimuthal asymmetry) has been observed for the first time in the nuclear Coulomb coherent production process, the "Primakoff process," with the use of the newly constructed 185-GeV/*c* Fermilab polarized proton beam. We have observed a large asymmetry of this process in the regions of $|t'|<0.001$ (GeV/*c*)^2 and $1.36<M(\pi^0\text{p})<1.52$ GeV/c^2, where the Coulomb process is predominant. The measured asymmetry is consistent with the analyzing power of the existing low-energy $\gamma+p\rightarrow\pi^0+p$ data.

31777 Limit on the flux of cosmic-ray magnetic monopoles from operation of an eight-loop superconducting detector. Huber, M.E. (Department of Physics, Stanford University, Stanford, California 94305 (US)); Cabrera, B.; Taber, M.A.; Gardner, R.D. *Physical Review Letters (USA)*, 64(8): 835-838 (19 Feb 1990). DOE Contract AT03-82ER40076.

An eight-loop superconducting magnetic monopole detector has been in continuous operation for 547 days, starting 4 March 1987. Its sensing area is 1.1 m^2 for double-coincident events. The data, which contain no candidate events, set an upper limit of 7.2×10^{-13} cm^{-2} s^{-1} sr^{-1} (90% confidence level) on the flux of monopoles of any mass and at any velocity passing through the Earth's surface.

31778 Kaon and pion production in central Si+Au collisions at 14.6*A* GeV/*c*. Abbott, T.; Akiba, Y.; Alburger, D.; Beavis, D.; Betts, R.R.; Birstein, L.; Bloomer, M.A.; Bond, P.D.; Chasman, C.; Chu, Y.Y. E-802 Collaboration. *Physical Review Letters (USA)*, 64(8): 847-850 (19 Feb 1990). DOE Contract AC02-76ER03069. NGR-05-003-513.

Semi-inclusive spectra of $\pi^{\pm}$, $K^{\pm}$, and *p* have been measured near midrapidity for central collisions of 14.6*A*-GeV/*c* ^{28}Si with ^{197}Au nuclei. The invariant cross sections are all well fit by exponential distributions in transverse mass, within the measured ranges. The π and *K* cross sections can also be fit by Boltzmann distributions. From integrated yields, at midrapidity, the kaon/pion yield ratios are (19.2±3)% for K^+/π^+ and (3.6±0.8)% for K^-/π^-; the π^+/π^- ratio is 1.00±0.04.

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Refer also to citation(s) 31749, 31750, 31751, 31753, 31754, 31756, 31759, 31804, 31808, 31856

31779 (ANL-HEP-CP–89-126) **QCD thermodynamics with light quarks and glueball spectra with dynamical quarks.** Sinclair, D.K. Argonne National Lab., IL (USA). High Energy Physics Div. Nov 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-8909249–12: Lattice '89: symposium on lattice field theory, Capri (Italy), 18-21 Sep 1989). Order Number DE90010546. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Simulations of Lattice QCD with 4 flavors of light staggered quarks (m = .025) were performed on a $12^3\times4$ lattice, confirming the first order nature of the transition. Lattice QCD with a light isodoublet of staggered quarks (m = .0125), and a heavier singlet (m = .25) was studied, also on a $12^3\times4$ lattice. The order of the transition was less clear. Improved glueball wavefunctions have been used to study glueball spectra in theories incorporating dynamical quarks. 10 refs., 3 figs.

31780 (BONN-IR–88-36) **Hamiltonian formalism of the Skyrme model with ω mesons.** Adami, C. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Jul 1988. 57p. (In German). Order Number DE90785080. Available from NTIS (US Sales Only), PC A04/MF A01.

We have in this thesis presented the semiclassical quantum theory of the Skyrme model with coupling to an isoscalar gauge field. For the quantization of the classical theory we used the Hamiltonian formalism. Furthermore we have studied the consequences of the canonical treatment, whereby we found the explicite πN vertex of the theory, as well as presented the correct treatment of the spatial contribution of the ω field. Furthermore we indicated that a consistent treatment requires the summation of all tree diagrams of the theory with internal π and ω lines. Such a calculation contains the explicite construction of solutions for the coupled $\pi\omega$ field equations. A further result of this thesis concerns the application of the linear πN vertex to the calculation of the Δ decay width via the process $\Delta\rightarrow$Nπ. (orig./HSI).

31781 (BONN-IR–89-42) **Determination of Baryon wave functions of the ground-state octet by means of QCD sum rules.** Pardon, R. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Nov 1989. 93p. (In German). Order Number DE90785078. Available from NTIS (US Sales Only), PC A05/MF A01.

In this work we investigate the wave functions of the baryons in the ground state octet by using the QCD sum rules technique, especially referring to the formalism of Chernyak and Zhitnitsky. The moments of the quark distibution amplitudes of the proton, Σ^+ and Ξ^- are determined by evaluating their sum rules graphically. For the necessary algebraic calculations we have developed a computer program package based on standard REDUCE, such that the Wilson coefficients could be calculated automatically. The contributions of the quark and gluon condensates up to energy dimension 6 have been taken into account. The corresponding quark distribution amplitudes of the cited baryons are plotted. Our results do not agree with those of a paper recently published by Chernyak, Ogloblin and Zhitnitsky and show, that the effects of the $SU(3)_F$ symmetry breaking by the mass of the strange quark are unexpectedly large. The electromagnetic form factors of the considered baryons are determined for an intermediate momentum transfer of several GeV. (orig.).

31782 (CNIC–00227) **Mechanisms of neutrinoless double beta decay and the mass of heavy neutrino.** Wu Huifang

(Academia Sinica, Beijing, BJ (China). Inst. of High Energy Physics); Huang Tao. China Nuclear Information Centre, Beijing, BJ (China). Jun 1988. 11p. (BIHEP-TH-0007). Order Number DE90625610. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The mechanisms of neutrinoless double beta decay in nuclei and the mass of heavy Majorana neutrino are analysed. The influence of the nuclear short-range correlation is also discussed.

31783 (CNIC-00270) **A new method for the determination of the spin of ξ (2230).** Yu Hong (Academia Sinica, Beijing, BJ (China). Inst. of High Energy Physics). China Nuclear Information Centre, Beijing, BJ (China). Aug 1988. 11p. (In English and Chinese). (BIHEP-0010). Order Number DE90625611. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The angular distributions of the photon for the moments of process $e^+e^- \rightarrow J/\psi \rightarrow \gamma B(J^\eta)$, $B(J^\eta) \rightarrow P_1+P_2$ have been given. It provides a new way to determine the spin of ξ (2230).

31784 (CONF-8905144-16) **Exotic hadrons and hadron dynamics at a tau-charm factory.** Close, F.E. (Oak Ridge National Lab., TN (USA)). Oak Ridge National Lab., TN (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Tau-Charm Factory workshop; Stanford, CA (USA); 23-27 May 1989. Order Number DE90010722. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Prospects for identifying hybrids and glueballs in ψ decays are summarized. 14 refs.

31785 (DOE/ER/40427-04-N90) **Parity violation and electron scattering.** Henley, E.M. Washington Univ., Seattle, WA (USA). Dept. of Physics. [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER40427. (CONF-9002117-1: Workshop on parity violation in electron scattering, Pasadena, CA (USA), 22-24 Feb 1990). Order Number DE90010429. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

I have been asked to set stage for the more specialized talks to follow and to review the history of parity nonconservation in electron scattering. In electron scattering, parity violation (PV) is the unique signal which allows us to study the weak interactions among the much stronger electromagnetic ones. It is observed through the detection of a pseudoscalar quantity in the cross section or rate of a reaction. These pseudoscalars usually involve a spin or polarization. Since it is known that spin effects are more sensitive to dynamics than differential or total cross sections, which are partially determined by geometry, PV measurements allow us to learn about the weak interactions and nucleon and nuclear structure. Because the weak interactions are of short range, the measurements are sensitive to different aspects of the target structure than the long range electromagnetic scattering. 15 refs., 7 figs.

31786 (FNAL/C-90/34-E) **Particle correlations in p-$\bar{p}$ interactions at $\sqrt{s}$ = 1800 and 630 GeV.** The CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8909291-9: 8. topical workshop on proton-antiproton collider physics, Castiglione della Pescaia (Italy), 1-5 Sep 1989). Order Number DE90010528. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Preliminary results on Bose-Einstein correlations and two particle pseudorapidity correlations in $p\bar{p}$ interactions at $\sqrt{s}$ = 1800 and 630 GeV are presented. Data were collected with a "minimum-bias" trigger with the Collider Detector at Fermilab. The size of the particle emitting source, measured via Bose-Einstein interference at $\sqrt{s}$ =1800 GeV, is of the order of 1 fm. The observed short-range pseudorapidity correlations, compared to lower energy data, do not show any significant energy dependence. 10 refs., 5 figs.

31787 (GSI-90-08(prepr.)) **Evaporation of hadrons from quark-gluon plasma globs.** Barz, H.W. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)); Schulz, H.; Friman, B.L.; Knoll, J. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 12p. Order Number DE90785012. Available from NTIS (US Sales Only), PC A03/MF A01.

We consider the hydrodynamic evolution of a hot droplet of quark-gluon plasma, taking the emission of hadrons from the surface of the droplet into account. The emission rates are estimated using detailed balance arguments for an evaporation process. We find that for droplets of low temperature the emission rate of baryons may well compete with that of pions. An important characteristic of the emission processes is that for reasonable values of the vacuum energy, the emission of a baryon leads to a heating rather than a cooling of the plasma. Thus the formation of long-lived cold plasma droplets is, even for non-zero net strangeness, very unlikely. (orig.).

31788 (LU-TP-89-10) **ARIADNE 3. A Monte Carlo for QCD cascades in the colour dipole formulation.** Loennblad, Leif. Lund Univ. (Sweden). Dept. of Theoretical Physics. Jun 1989. 15p. Order Number DE90625642. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A Monte Carlo program for generating QCD cascades, based on the colour dipole approximation is presented. The program is an extension of the program ARIADNE 2, including gluon splitting in the colour dipole formulation of QCD. (author).

31789 (LU-TP-89-16) **A phenomenological investigation of the string effect.** Khoze, V. (Lenningrad Nuclear Physics Institute, Gatchina (USSR)); Loennblad, L. Lund Univ. (Sweden). Dept. of Theoretical Physics. Oct 1989. 7p. Order Number DE90625643. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We present results from Monte Carlo calculations of the string effect and the double inclusive correlation of particle flows, for three-fold symmetric three-jet events in e^+e^- annihilation reactions at different energies. We find that the perturbative phase of the jet evolution quickly becomes dominant as energy increases. (authors).

31790 (RAL-89-137) **A very light Higgs at LEP.** Brown, N. Rutherford Appleton Lab., Chilton (UK). Jan 1990. 5p. Order Number DE90625645. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

If the standard Higgs particle is very light ($\leq$50 MeV) then it will be sufficiently long lived that it could decay outside the detectors at LEP. This could give a signal of two final state leptons which are not back-to-back, with missing transverse momentum. We show that with suitable cuts this Higgs signal can be distinguished from backgrounds with a large enough rate that such a light Higgs will either be discovered or completely ruled out. (author).

31791 (SLAC-PUB-5204) **The need for the next linear collider.** Gilman, F.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Feb 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8907190-1: 1. international workshop on accelerator alignment, Stanford, CA (USA), 31 Jul - 2 aug 1989). Order Number DE90010176. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The need for the next generation electron-positron collider is discussed within the context of the Standard Model and the physics that must lie beyond it.

31792 (SLAC-PUB-5210) **Theory of precision electroweak measurements.** Peskin, M.E. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 54p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8907134-9: 17. SLAC summer institute: physics at the 100 GeV mass scale, Stanford, CA (USA), 10-21 Jul 1989). Order Number DE90010179. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

In these lectures, I will review the theoretical concepts needed to understand the goals and implications of experiments in this new era of weak interactions. I will explain how to compute the most important order-α radiative corrections to weak interaction processes and discuss the physical implications of these correction terms. I hope that this discussion will be useful to those — experimentalists and theorists — who will try to interpret the new data that we will soon receive. This paper is organized as follows: I will review the structure of the standard weak interaction model at zeroth order. I will discuss the measurement of the Z^0 boson mass in

e^+e^- annihilation. This measurement is affected by radiative correction to the form of the Z^0 resonance, and so I will review the theory of the resonance line shape. I will briefly review the modifications of the properties of the Z^0 which would be produced by additional neutral gauge bosons. I will review the theory of the renormalization of weak interaction parameters such as $\sin^2\theta_w$, concentrating especially on the contributions of the top quark and other heavy, undiscovered particles.

31793 **Probing the $WW\gamma$ vertex at a 1-TeV e^+e^- collider using the process $e\gamma\rightarrow W\nu$.** Yehudai, E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)). *Physical Review, D (Particles Fields) (USA),* 41(1): 33-41 (1 Jan 1990). DOE Contract AC03-76SF00515.

We suggest that, at a future TeV-energy linear e^+e^- collider, the process $e\gamma\rightarrow W\nu$ will give an effective measurement of the $WW\gamma$ vertex. By measuring the total cross section and the forward-backward asymmetry, the couplings κ and λ can be measured to a few-percent accuracy.

31794 **Modeling parton spin-transfer densities.** Qiu, J. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Ramsey, G.P.; Richards, D.; Sivers, D. *Physical Review, D (Particles Fields) (USA),* 41(1): 65-82 (1 Jan 1990). DOE Contract W-31109-ENG-38.

We present models for the spin-weighted quark and gluon distribution in a longitudinally polarized proton. The models embody different underlying concepts concerning the application of spin-dependent forces in the nonperturbative or "soft" regime of chromodynamics. The different spin densities are used to investigate a possible long-range experimental program for measuring various hard-scattering processes using polarized protons.

31795 **Single-spin production asymmetries from the hard scattering of pointlike constituents.** Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)). *Physical Review, D (Particles Fields) (USA),* 41(1): 83-90 (1 Jan 1990). DOE Contract W-31109-ENG-38.

When one takes into account the transverse momenta of the constituents in a polarized proton, there exists a kinematic, "trigger-bias," effect in the formulation of the QCD-based hard-scattering model which can lead to single-spin production asymmetries. It seems convenient to represent the coherent spin-orbit forces in a polarized proton by defining an asymmetry in the transverse-momentum distribution of the fundamental constituents. It may then be possible to organize the hard-scattering model so that the kinematic constraints of hard $2\rightarrow2$ scattering provide the leading contribution at large transverse momentum to asymmetries of the type $A_N d\sigma(hp_\uparrow\rightarrow jet+x)$, $A_N d\sigma(hp_\uparrow\rightarrow\pi^+x)$, where $p_\uparrow$ denotes a transversely polarized proton and "π" represents any spinless meson composed of light quarks. This approach provides testable relationships between different asymmetries.

31796 **Phenomenology and cosmology of extra generations of Higgs bosons.** Griest, K. (Center for Particle Astrophysics, University of California, Berkeley, California 94720 (USA)— Astronomy and Astrophysics Center, University of Chicago, Chicago, Illinois 60637 (USA)); Sher, M. *Physical Review Letters (USA),* 64(2): 135-138 (8 Jan 1990).

If the Higgs sector (like the fermion sector) in a supersymmetric model consists of several generations, then a basis in which only one generation gets vacuum values can be chosen. The other generations have been largely ignored, but can be interesting. For example, in the minimal model, if tree-level flavor-changing neutral currents are eliminated by some symmetry, then the lightest of these scalars is stable and the second lightest is only slightly more massive. The lightest is a superb dark-matter candidate, and if light enough, gives an unusual and detectable signature at the SLAC Linear Collider or the CERN e^+e^- collider LEP.

31797 **Nucleon structure with pion clouds in a flux-tube quark model.** Kumano, S. (Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37996-1200 (US)— Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831— Department of Physics, University of Illinois at Urbana-Champaign,. *Physical Review, D (Particles Fields) (USA),* 41(1): 195-202 (1 Jan 1990). DOE Contract AC05-84OR21400.

Nucleon structure with pion clouds is studied in the framework of a flux-tube quark model. The meson clouds are produced by breaking flux tubes in the nucleon; then a baryon is described by three valence quarks connected by color fields and other configurations including sea quarks. These sea quarks (or meson clouds) generate baryon decay widths and shift their masses; therefore, the hadron spectroscopy in constitutent-quark models should be investigated again by including these mass shifts. In this flux-tube model, the Yukawa potential is explained by a piece of the flux tube breaking off from a nucleon and attaching itself to the other.

31798 **Analysis of semileptonic decays of mesons containing heavy quarks.** Gilman, F.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)); Singleton, R.L. Jr. *Physical Review, D (Particles Fields) (USA),* 41(1): 142-150 (1 Jan 1990). DOE Contract AC03-76SF00515.

We analyze semileptonic decays of mesons containing heavy quarks and indicate how to extract the signs and magnitudes of the helicity amplitudes for the exclusive decay modes involving a vector meson, lepton, and neutrino by using the joint distribution of the decay products of the vector meson (into a pair of pseudoscalar mesons) and of the virtual W (into a charged lepton and its neutrino). We apply this to specific cases of charm- and bottom-meson decays with form factors calculated from quark models.

31799 **Heavy-quarkonium decay into Z+Higgs boson as a scalar/pseudoscalar discriminant.** Pantaleone, J. (Physics Department, University of California at Riverside, Riverside, California 92521 (USA)); Roy, P. *Physical Review Letters (USA),* 64(3): 264-267 (15 Jan 1990). DOE Contract AM03-76SF00010;FG02-85ER40209.

The heavy-quarkonium decay $^3S_1(Q\bar{Q})\rightarrow Z$+Higgs boson, a feasible process for Higgs-boson searches, is shown to be highly sensitive to the structure of the $HQ\bar{Q}$ vertex. A study of the angular distributions of the Z decay products can distinguish between the scalar or pseudoscalar form of this vertex and provide important information on the electroweak-symmetry-breaking mechanism.

31800 **Radiative corrections to Higgs-boson-mass sum rules in the minimal supersymmetric extension to the standard model.** Berger, M.S. (Department of Physics, University of California, Berkeley, CA (US)— Theoretical Physics Group, Physics Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)). *Physical Review, D (Particles Fields) (USA),* 41(1): 225-239 (1 Jan 1990). DOE Contract AC03-76SF00098.

The mass sum rules involving Higgs bosons that arise in supersymmetric extensions to the standard model are renormalized. The general procedure for calculating radiative corrections to these relations is presented. The radiative corrections from loop contributions of quarks, leptons, and their supersymmetric partners to the mass relation $M_H{}^2+M_h{}^2=M_A{}^2+M_Z{}^2$ of the minimal supersymmetric extension to the standard model are derived. The results indicate that large corrections to the sum rules may arise from heavy matter fields. Squarks significantly heavier than their fermionic partners contribute large contributions when mixing occurs in the squark sector. These large corrections result from squark–Higgs-boson couplings that become large in this limit. Contributions to individual Higgs-boson masses that are quadratic in the squark masses cancel in the sum rule. Thus the naturalness constraint on Higgs-boson masses is hidden in the sum rule.

31801 **Box diagrams and mixings with heavy external quarks.** Nandi, S. (Department of Physics, Oklahoma State University, Stillwater, Oklahoma 74078 (US)); Zhang, L. *Physical Review, D (Particles Fields) (USA),* 41(1): 240-247 (1 Jan 1990). DOE Contract FG05-85ER40215.

We present, within the standard model, an exact calculation of the effective Hamiltonian generated by the box diagrams when both the external and internal quarks are arbitrarily heavy. We use this result to calculate the mixings of the neutral hadrons involving one fourth-generation quark. Large $B_b{}'-\bar{B}_b{}'$ ($B_b{}'=b'\bar{b}$) mixing is predicted for a wide range of b'-, t-, and t'-quark masses.

31802 Polarized strange quarks in the proton and the validity of quantum chromodynamics. Close, F.E. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6373 (US)— Department of Physics, University of Tennessee, Knoxville, Tennessee 37996-1200). *Physical Review Letters (USA)*, 64(4): 361-363 (22 Jan 1990). DOE Contract AC05-84OR21400.

Recent claims that the European Muon Collaboration (EMC) data on polarized proton structure functions violate quantum chromodynamics are shown to be unfounded and driven by the use of an incorrect or outdated balue of the *F/D* ratio for hyperon decays. Conclusions from the EMC experiment as to the amount of strange-sea polarization are rather sensitive to this value. Contrary to some statements in the literature, elastic-neutrino-scattering data are consistent with vanishing strange polarization.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 31785, 31808, 31815, 31817

31803 Dynamical symmetry breaking and the top-quark mass. Marciano, W.J. (Brookhaven National Laboratory, Upton, New York 11973 (US)). *Physical Review, D (Particles Fields) (USA)*, 41(1): 219-224 (1 Jan 1990). DOE Contract AC02-76CH00016.

Dynamical symmetry breaking by fermion condensates is assumed to be the source of gauge-boson masses in the $SU(3)_C \times SU(2)_L \times U(1)$ model. For the minimal case of $t\bar{t}$ condensation alone, the predicted m_t ranges from about 98 to 450 GeV as the scale of "new physics," responsible for m_t,Λ, goes from ∞ to $\sim$1 TeV. The lighter values, $m_t \lesssim 200$ GeV, all correspond to "great desert" scenarios with $\Lambda \gtrsim m_{Planck} \cong 2\times10^{19}$ GeV. Including a fourth generation of fermion condensates can lower m_t. In the case of maximal t-t' mixing, we find $m_t \cong m_{t'} \cong (\sqrt{3}/2)m_{b'}$ with m_t ranging from about 90 to 250 GeV, and $m_t \cong 140$ GeV for $\Lambda \cong 10^{15}$–10^{19} GeV. For smaller mixing, m_t is lowered and $m_{t'}$ approaches $m_{b'}$. We speculate as to how, using strong-coupling unitarity conditions, one might have $m_t \lesssim 200$ GeV with Λ far below m_{Planck}. Phenomenological constraints and consequences are also discussed.

31804 Breakdown of nonet symmetry in Cabibbo-allowed decays of charmed mesons into two pseudoscalars. Rosen, S.P. (T-Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)). *Physical Review, D (Particles Fields) (USA)*, 41(1): 303-305 (1 Jan 1990).

We assume the flavor-symmetry properties predicted by the standard model for the decays of charmed mesons into two pseudoscalar mesons and test the additional hypothesis of nonet symmetry. From the measured branching ratios for D^+ and D^0, we show that nonet symmetry must be badly broken for the pseudoscalar nonet. Because the branching ratios for the D_s meson are not well known at present, we cannot determine whether one of the SU(3) representations 6^* and 15 dominates the effective interaction. There are some indications that both are equally important.

6454 Field Theory

Refer also to citation(s) 31753, 31779, 31794, 31795, 31800, 31801, 31909

31805 (ANL-HEP-CP–90-07) **Quantum maps for deformed algebras.** Zachos, C.K. Argonne National Lab., IL (USA). High Energy Physics Div. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-900135–4: General meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX (USA), 3-6 Jan 1990). Order Number DE90010583. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We find explicit functionals that map SU(2) algebra generators to those of several quantum deformations of that algebra. We indicate how any such quantized algebra can be mapped to any other, and how representations of any such algebra can be expressed as simple functions of SU(2) representations. The representation theory and its comultiplication rules are thus systematized and streamlined by direct reference to their SU(2) correspondents. We speculate on quantum deformations of the Virasoro algebra. 13 refs.

31806 (CTA-IEAv-RP–05/85) **Soliton resonance in weak periodic fields.** Geicke, J. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. 14 Mar 1985. 8p. Order Number DE90625288. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The motion of a ϕ^4 kink in a weak external field $F(t) = f_0\cos\omega t$ is discussed. Due to the resonance between the external force and the vacuum excitation a beat effect is expected in the oscillations of the kink around its average position and observed in numerical experiments. (author).

31807 (DOE/ER/01545–438) **Study of nonperturbative continuum limits in a lattice Yukawa model.** Aoki, S. (State Univ. of New York, Stony Brook, NY (USA). Inst. for Theoretical Physics); Shrock, R.E.; Lee, I-H.; Mustaki, D.; Shigemitsu, J. Ohio State Univ., Columbus, OH (USA). Dept. of Physics. [1990]. 12p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC02-76ER01545;AC02-87ER40325. Grant PHY-89-08495. (ITP-SB–89-93;RU–89/B1/53). Order Number DE90009730. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Using analytic methods and dynamical fermion simulations, we study the properties of two nonperturbative continuum limits of a lattice Yukawa model with a real scalar field, at the (a) ferromagnetic-ferrimagnetic and (b) ferrimagnetic-antiferromagnetic phase boundaries. This work makes use of a new analytic result that the fermion mass vanishes identically in the the antiferromagnetic phase. 15 refs., 3 figs.

31808 (DOE/ER/01545–440) **Fermions in the hypercharge sector of the standard lattice electroweak theory: Global limit.** Aoki, Sinya (State Univ. of New York, Stony Brook, NY (USA). Inst. for Theoretical Physics); Shrock, R.E.; Lee, I-Hsiu; Shigemitsu, Junko. Ohio State Univ., Columbus, OH (USA). Dept. of Physics. [1990]. 13p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC02-76ER01545;AC02-87ER40325. Grant PHY-89-08495. (ITP-SB–89-40;RU–89/B1/55). Order Number DE90009731. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We study the global limit of the hypercharge $U(1)_Y$ sector of the standard lattice electroweak theory. We show that for fermions with both $Y_R = 0$ and $Y_R \neq 0$ the doubler modes can be removed in the continuum limit while the physical fermion masses can be tuned to agree with physical values. 18 refs., 1 fig., 1 tab.

31809 (IFUSP-P–790) **String production as a result of thermal fluctuations.** Guerra Junior, J.M. (Brasilia Univ., DF (Brazil). Dept. de Matematica); Marques, G.C.; Rodrigues, S.J. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. Jun 1989. 44p. Order Number DE90625289. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Based on the analysis of the free energies of topological defects the study of phase transitions in field theory at finite temperature, was developed. In the case of strings, it is shown one can get, in dilute gas approximation, explicit expressions for the lenght of the string as well as the density contrast in terms of the free energy per unit lenght of the string. In the high temperature limit one can get explicit expressions for all revelant quantities up to one-loop approximation. When applied to the SO(10) model, good phenomenological results are obtained. In particular, the scale independent Zel'dovich spectrum with the right order of magnitude, is derived in a simple manner. (author).

31810 (LA-UR–90-1390) **Open superstrings as the theory of everything?.** Bern, Z. (Los Alamos National Lab., NM (USA)); Dunbar, D.C. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900135–2: General meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX (USA), 3-6 Jan 1990). Order Number DE90010613. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We discuss the first examples of one-loop finite four-dimensional superstrings. These examples can be either space-time supersymmetric or not depending on the details of the models. 17 refs.

31811 (NBI-HE–90-02) **Absence of static solitons in vectorlike gauge theories.** Ball, R.D. Niels Bohr Inst., Copenhagen (Denmark). Jan 1990. 12p. Order Number DE90625292. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

It is shown using the positivity of the measure of functional integration that static solitons in quantised vectorlike gauge theories inevitably collapse unless supported by valence fermions. Thus if QCD is the correct theory of strong interactions, baryons are not Skyrmions. (orig.).

31812 (NBI-HE–90-04) **Classification of networks of automata by dynamical mean field theory.** Burda, Z. (Uniwersytet Jagiellonski, Krakow (Poland). Inst. Fizyki); Jurkiewicz, J.; Flyvbjerg, H. Niels Bohr Inst., Copenhagen (Denmark). Jan 1990. 11p. Contract CPBP 01.03;CPBP 01.09. Order Number DE90625293. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Dynamical mean field theory is used to classify the 2^{24}=65,536 different networks of binary automata on a square lattice with nearest neighbour interactions. Application of mean field theory gives 700 different mean field classes, which fall in seven classes of different asymptotic dynamics characterized by fixed points and two-cycles. (orig.).

31813 (NBI-HE–90-06) **1/N-expansion of the non-linear σ-model: The first three orders.** Flyvbjerg, H.; Varsted, S. Niels Bohr Inst., Copenhagen (Denmark). Jan 1990. 15p. Contract DNSRC 11-8029. Order Number DE90625295. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The two-point function of the O(N)-symmetric non-linear σ-model is expanded in 1/N, keeping terms of three leading orders. The mass gap and the magnetic susceptibility are obtained from the two-point function. They are evaluated on square lattices for N=3 and N=4. The systematic errors of the 1/N-series truncated after the first, second, or third term are found by using recent high precision Monte Carlo results as bench marks. For all three truncations, we find systematic errors which are smaller than the expected magnitude of neglected terms, both for the mass gap and for the susceptibility. This result is uniform in the inverse coupling β, and valid for N as small as 3. We conclude that the 1/N-series approach the exact results as rapidly as one could ever hope for. (orig.).

31814 (NORDITA–89/41-P(prepr.)) **A vertex including emission of spin fields.** Di Vecchia, P. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)); Madsen, R.; Hornfeck, K.; Roland, K.O. Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark). Oct 1989. 14p. (LAPP-TH–268/89). Order Number DE90625296. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We construct the (N+2M) Point Vertex involving the emission of N Neveu-Schwarz states and 2M Ramond states for a fermionic system with λ=1/2. From it one can compute correlation functions involving any number of spin fields. (orig.).

31815 (SLAC-PUB–5229) **Supersymmetry breaking in string theory.** Dixon, L.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-900135–3: General meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX (USA), 3-6 Jan 1990). Order Number DE90010181. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

I briefly review the problems with previous investigations of supersymmetry breaking in string theory — at tree-level, at one-loop, and non-perturbatively. A variant of the original non-perturbative scenario is proposed, in which gaugino condensation takes place in two different strongly-interacting hidden-sector gauge groups. In the new scenario it is possible to generate a large hierarchy of mass scale and to simultaneously stabilize the dilaton at a large expectation value (weak coupling). However, it is still uncertain whether supersymmetry is broken in such a vacuum. 26 refs.

31816 How to use MACSYMA to write long FORTRAN codes for noncompact simulations of gauge theories. Cahill, K. (High-Energy-Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)— Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138 (US)— Department of Physics and Astronomy, University of New Mexico, Albuqu *Computers in Physics (USA)*, 4(2): 159-165 (Mar 1990). DOE Contract FG04-84ER40166;W-31109-ENG-38.

This paper shows how to use the symbol manipulator MACSYMA to do arbitrarily long calculations and how to translate the typically lengthy results into FORTRAN so that they can be tested, appreciated, and used. This procedure is illustrated by its application to the task of writing the code for a noncompact lattice simulation of a nonabelian gauge theory.

31817 Conformal field theories for the Green-Schwarz superstring. Brooks, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)). *Physical Review, D (Particles Fields) (USA)*, 41(2): 468-471 (15 Jan 1990). DOE Contract AC03-76SF00515.

The energy-momentum tensor of the covariantly quantized Green-Schwarz heterotic superstring in D dimensions is found to be equivalent to that of an $s\hat{o}(2(D-2))_{k=2}\oplus\hat{0}(1)$ theory. Both the naive R symmetry and the κ ghost number symmetry are found to be anomalous. However, a certain linear combination of these two U(1) currents is free of anomalies.

65 PHYSICS II

6510 Nuclear Physics

Refer also to citation(s) 31288, 31860

31818 (CNIC–00246) **Fully microscopic DWBA analyses on ^{89}Y (α, p)^{92}Zr reaction.** Yuan Jian (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Mao Zhiqiang; Zhang Peihua. China Nuclear Information Centre, Beijing, BJ (China). 1988. 10p. (In Chinese). (IAE–0058). Order Number DE90625882. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The differential cross sections have been measured for the ^{89}Y (α, p) ^{92}Zr reaction with some low-lying states and the ^{89}Y (α, α) ^{89}Y elastic scattering by using 26.1 MeV α beam. A fully microscopic DWBA analyses for ^{89}Y (α, α) ^{92}Zr have been performed by using ^{89}Y and ^{92}Zr shell-model wavefunction with or without the core excited configuration. With the core excited configuration, relative strengths of the ground state and the first excited state are greatly improved. Finally, the absolute cross sections for ^{89}(α, p) ^{92}Zr and importance of shallow well depth of α potential are discussed.

31819 (GSI–90-03) **Report of the Expert Committee 'Nuclear Physics and Heavy-Ion Research' 1986-1988/89.** Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 37p. (In German). Order Number DE90785124. Available from NTIS (US Sales Only), PC A03/MF A01.

This report of the Expert Committee 'Nuclear Physics and Heavy-Ion Research' for the years 1986-1988/89 is based on the results of the projects sponsored by the Federal Minister of Research and Technology in the framework of this complex. The presentation gives a survey, but confines particularly to examples without claim for completeness. The report is supplemented by statistical informations about the development and sponsoring of the complex. (orig./HSI).

31820 (INDC(NDS)–232/L) **Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.** Wang Dahai (ed.). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. 99p. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The proceedings contain the progress reports of the Coordinated Research Programme to measure and evaluate the activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology and the contributed papers

(9) presented at the Consultants' Meeting held at Argonne National Laboratory between 11-12 September 1989. A separate abstract was prepared for each paper. Refs., figs., and tabs.

31821 (LUIP–8811) **Light particle emission and projectile breakup in 35A MeV ^{12}C induced collisions.** Westenius, M. (Lund Univ. (Sweden). Dept. of Physics); Berg, M.; Gustafsson, H.Aa. Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics. Jul 1989. 39p. Order Number DE90625880. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Inclusive spectra of p, d, t, ^3He from 35A MeV ^{12}C + C, Al, Cu, Au reactions as wll as coincidences between projectile-like fragments and light particles have been measured. The apparent temperature does not seem to depend on the size of the coincident fragment. An independent way to determine source velocities indicates that high energy protons are emitted from a source with a velocity close to half the beam velocity even in assymmetric reactions. We observed in in-plane enhancement in the azimuthal angular distributions of coincident projectile-like fragments which gets stronger with increasing mass of the triggering particle or the fragment. A discussion around momentum conservation effects shows that p * B correlations may originate form a combination of pure projectile breakup- and nucleon-nucleon quasi-elastic scattering process. The correlations observed in less peripheral collision need the introduction of a second, light particle emitting source.

31822 (LUIP–8910) **Deviations from pure target fragmentation in 94A MeV ^{16}O induced heavy ion reactions.** Gustafsson, H.Aa. (Energiforskningsnaemnden, Stockholm (Sweden)); Jakobsson, B.; Kristiansson, A. Lund Univ. (Sweden). Dept. of Cosmic and Subatomic Physics. Oct 1989. 14p. (LUNFD6-NFFK–7107-1-10-1989). Order Number DE90625887. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The emission of low energy, 1A MeV - 6A MeV, medium size, Z = 3 -17, fragments in ^{16}O + ^{27}Al, ^{48}Ti, ^{197}Au reactions at 94A MeV has been studied. In addition to a fragmentation component with about 15A MeV/c parallel- and transverse momentum shifts, another component with larger momentum width is needed to describe the results. The momentum transfer and momentum distributions of heavier fragments are resonably well described by a VUU prescription whereas the large momentum transfer component indicates the decay from excited primary fragments is important. (authors).

31823 (PTB-Ra–16/3(ed.3)) **Half-lives and photon emission probabilities of frequently applied radionuclides.** Schoetzig, U.; Schrader, H. Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Radioaktivitaet. Sep 1989. 64p. (In German). Order Number DE90784926. Available from NTIS (US Sales Only), PC A04/MF A01.

Tabellary compilation emisssion probabilities and half-lives of about 100 hitherto studied radionuclides are listed. The data have partly been measured in the PTB, partly they originate from other data compilations, or several such values were averaged; many of these values were checked by own measurements. (orig./HP).

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

Refer also to citation(s) 31122, 31758, 31827

31824 (GSI–90-04) **Study of the (d,p) reaction on medium-heavy nuclei in inverse kinematics.** Kraus, G. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Mainz Univ. (Germany, F.R.). Feb 1990. 96p. (In German). Order Number DE90785111. Available from NTIS (US Sales Only), PC A05/MF A01.

For the nuclear-structure studies on double-magic nuclei far beyond the valley of stability in inverse kinematics with radioactive heavy-ion beams and light target nuclei planned at the SIS/ESR accelerator in the framework of a test experiment at the UNILAC the measurement technique and the experimental conditions were studied. For this with a stable xenon beam the reactions d(^{136}Xe, p)$^{137}Xe^*$ and d(^{132}Xe,p)$^{133}Xe^*$ at 5.868 MeV/u incident energy were studied in inverse kinematics. A scattering chamber of the MPI for Nuclear Physics in Heidelberg was modified correspondingly to the requirement of the experiment and erected at the experimental area Z6 of the GSI Darmstadt. As detectors a new developed array of 10x10 PIN diodes as well as some detector telescopes of PION diodes were applied. For the readout of the detector array an analysis program was developed; integrated to the GSI data aquisition system GOOSY, and tuned to the applied electronics. During the experiment energy resolutions of typically 100 keV in the c.m. system and time resolutions in the range 1-2 ns were reached. In the residual nuclei discrete levels could be identified up to an excitation energy of 4.5 MeV. Angular distributions for the cross sections of elastically scattered protons and deuterons between 20deg and 70deg (c.m.) were taken up and from them by means of optical-model calculations the potential parameters for the DWBA analysis of the (d,p) data extracted. The angular distributions for protons from (d,p) reactions were analyzed in the range 10deg-50deg (c.m.) by a finite-range DWBA code. Spin and parity assignments, excitation energies, and spectroscopic factors could be determined for the strong observed states. (orig./HSI).

31825 (SLAC–357) **Deep inelastic structure functions from electron scattering on hydrogen, deuterium, and iron at 0.6 GeV^2 $\leq Q^2 \leq$ 30.0 GeV^2.** Whitlow, L.W. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Mar 1990. 203p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE90010169. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

We report the final results from experiment E140, a recent deep inelastic electron-deuterium and electron-iron scattering experiment at SLAC. In addition, we present the results of a combined global analysis of all SLAC deep inelastic electron-hydrogen and electron-deuterium cross section measurements between 1970 and 1983. Data from seven earlier experiments are re-radiatively corrected and normalized to experiment E140. We report extractions of $R(x,Q^2)$ and $F_2(x,Q^2)$ for hydrogen and deuterium over the entire SLAC kinematic range: $.06 \leq x \leq .90$ and $0.6 \leq Q^2 \leq 30.0$ (GeV^2). We fine that $R^p = R^d$, as expected by QCD. Extracted values of $R(x,Q^2)$ are significantly larger than predictions based on QCD and on QCD with the inclusion of kinematic target mass terms. This difference indicates that dynamical higher twist effects may be important in the SLAC kinematic range. A best fit empirical model of $R(x,Q^2)$ is used to extract F_2 from each cross section measurement. These F_2 extractions are compared with F_2 data from EMC and BCDMS. Agreement is observed with EMC when the EMC data are multiplied by 1.07. Agreement is observed with BCDMS over a limited range in x. The ratios of F_2^d/F_2^p are examined for Q^2 dependence. We observe a significant negative slope for $x \leq .6$, and a significant positive slope above $x > .7$, in excellent agreement with predictions based on QCD with the inclusion of kinematic target mass terms. 111 refs., 40 figs., 34 tabs.

31826 **Search for protons from the $^2H(d,p)^3H$ reaction in an electrolytic cell with Pd-Pt electrodes.** Rehm, K.E. (Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Kutschera, W.; Perlow, G.J. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 45-49 (Jan 1990). DOE Contract W-31109-ENG-38.

The production of protons from the $^2H(d,p)^3H$ reaction was investigated using an electrolytic cell and a proportional counter. The cathode, consisting of a 30.5-mg/cm^2-thick Pd foil, separated the gas in the counter from the electrolyte (0.1*M* LiOD in D_2O). The efficiency for proton detection was 28%. The electrolytic cell was operated with current densities up to 650 mA/cm^2. Several runs with the current switched on and off and with different Pd foils have been performed with the longest run lasting more than 10 days. No difference in the count rate was observed when the electrolytic cell was on or off. From the high-energy part of the particle spectrum we obtain an upper limit for the proton production from the fusion reaction $^2H(d,p)^3H$ of 4×10^{-23} fusion/(*dd* pair/sec).

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

Refer also to citation(s) 31758

31827 (DOE/ER/40085–19) **A study of intranuclear rescattering in ν_μ-Ne versus ν_μ-D interactions: Implications for nucleon decay searches.** Merenyi, R.C. Tufts Univ., Medford, MA

(USA). Dept. of Physics and Astronomy. c 1 May 1990. 200p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-83ER40085. Order Number DE90010662. Available from NTIS, PC A10/MF A01; OSTI; INIS.

Pion intranuclear rescattering rates are determined for processes which can distort reaction final states observed and/or searched for in nucleon decay experiments. We compare the interactions of low energy neutrinos with neon versus deuterium nuclei, weighted to simulate the atmospherically-induced spectrum. The pion charge exchange and absorption rates, expressed as probabilities per final state pion, are measured to be 0.05 $\pm$ 0.09 and 0.23 $\pm$ 0.08, respectively. Using the excess momentum degraded, backscattered pions in neon relative to deuterium, we measure a lower limit for π^- inelastic rescattering to be 0.11 $\pm$ 0.10 and for π^+ to be 0.03 $\pm$ 0.04. The apparent charge dependence of $\pi^\pm$ inelastic rates may be associated with abundant Δ^{++} production in threshold ν_μ interactions. The resonance lifetime allows "transport" of π^+ mesons to the lower density nuclear periphery, prior to $\Delta^{++} \rightarrow p\pi^+$ decay. The pion rescattering rates are used to calibrate a simple phenomenological cascade model for A = 20. The model enables extrapolation of pion rescattering rates for higher atomic number nuclei, e.g. argon and iron, detector media which are being employed in second generation current nucleon decay searches.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

Refer also to citation(s) 31825, 31830, 31831

31828 (GSI–90-07(prepr.)) **Rapidity distributions of Ca+Ca, Nb+Nb, Ne+Au and Au+Au at bombarding energies from 250 to 2100 MeV/nucleon.** Gutbrod, H.H. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Kolb, B.W.; Schmidt, H.R.; Kampert, K.H.; Poskanzer, A.M.; Ritter, H.G. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Feb 1990. 28p. Order Number DE90784995. Available from NTIS (US Sales Only), PC A03/MF A01.

We present experimental rapidity distributions dN_{ch}/dy over a wide range of bombarding energies and projectile and target masses. Target and projectile spectators are observed for peripheral collisions but not for the most central collisions. This behavior is found for all systems and bombarding energies investigated. Although detector inefficiencies tend to distort the experimental distributions, they are on a tolerable level and do not remove sensitivity to theoretical descriptions. (orig.).

31829 (IFUSP-P–750) **Fusion of ^{16}O+46,50Ti near and below the Coulomb barrier.** Liguori Neto, R.; Acquadro, J.C.; Gomes, P.R.S.; Toledo, A.S. de; Crema, E.; Carlin Filho, N.; Coimbra, M.M. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. Nov 1988. 20p. Order Number DE90625900. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Fusion excitation functions for the systems ^{16}O+ $^{46,50}Ti$ at bombarding energies in the range 30 MeV $\leq E_{LAB}(^{16}O) \leq$ 65 MeV were measured by means of the γ-ray spectroscopy technique. The fusion excitation functions are analysed using a semi-classical one-dimensional barrier-penetration model with different nuclear potentials describing the heavy-ion interaction. From the analysis the fusion barrier parameters were obtained. The observed fusion cross sections at subbarrier energies are larger than predicted by this conventional one-dimensional barrier-penetration model. The fusion enhacement at sub-barrier energies for these systems can be explained by the simple approach of Wong's model, considering explicitly the quadrupole deformation parameter of the target-nucleus. (author).

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 31835, 31840

31830 (INDC(NDS)–232/L, pp. 17-31) **Measurement of the cross sections for the reactions $^{52}Cr(n,2n)^{51}Cr$, $^{66}Zn(n,2n)^{65}Zn$, $^{89}Y(n,2n)^{88}Y$ and $^{96}Zr(n,2n)^{95}Zr$ from 13.5 to 14.8 MeV.** Wagner, M. (Vienna Univ. (Austria). Inst. fuer Radiumforschung und Kernphysik); Winkler, G.; Vonach, H.; Buczko, C.M.; Csikai, J. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. Contract 259/86;Contract 144/88. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Cross sections for the reactions $^{52}Cr(n,2n)^{51}Cr$, $^{66}Zn(n,2n)^{65}Zn$, $^{89}Y(n,2n)^{88}Y$ and $^{96}Zr(n,2n)^{95}Zr$ were measured in the energy range 13.47 MeV to 14.79 MeV applying the activation technique. Energy of neutrons produced via the $T(d,n)^4He$ reaction was changed by the emission angle. The neutron fluences and energies incident on the samples were determined by the measurements of the ^{92m}Nb and ^{89}Zr specific activities produced in the $^{93}Nb(n,2n)$ and $^{90}Zr(n,2n)$ reactions. The induced γ-ray activities of the irradiated Cr, Zn, Zr ahd Y_2O_3 samples and their monitor foils were measured by means of calibrated Ge(Li) and NaI well-type γ-ray detectors. The results compared to the corresponding data in the literature show that the uncertainties obtained in this work are considerably smaller in most cases than those given by other authors. (author). 57 refs, 5 figs, 2 tabs.

31831 (INP–1344/PS, pp. 246-259) **Sub-barrier fusion at L.N.L.** Stefanini, A.M. (Istituto Nazionale di Fisica Nucleare, Legnaro (Italy)); Fortuna, G.; Pengo, R. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Heavy ion fusion reactions at energies below the Coulomb barrier are studied. It is shown how this process can be understood quantum mechanically. The experimental results for the different beams and targets (systems of sulfur and nickel isotopes) are summarized. 11 refs., 9 figs. (M.F.W.).

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 31828, 31830, 31839, 31842, 31843, 31865

31832 (ANL/NDM–115) **Evaluated neutronic file for indium.** Nuclear data and measurements series. Smith, A.B. (Argonne National Lab., IL (USA)); Chiba, S.; Smith, D.L.; Meadows, J.W.; Guenther, P.T.; Lawson, R.D.; Howerton, R.J. Argonne National Lab., IL (USA). Jan 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90010753. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A comprehensive evaluated neutronic data file for elemental indium is documented. This file, extending from 10^{-5} eV to 20 MeV, is presented in the ENDF/B-VI format, and contains all neutron-induced processes necessary for the vast majority of neutronic applications. In addition, an evaluation of the $^{115}In(n,n')^{116m}In$ dosimetry reaction is presented as a separate file. Attention is given in quantitative values, with corresponding uncertainty information. These files have been submitted for consideration as a part of the ENDF/B-VI national evaluated-file system. 144 refs., 10 figs., 4 tabs.

31833 (DOE/ER/40345–14) **On-line nuclear orientation: Progress report, April 1, 1989–March 31, 1990.** Krane, K.S. Oregon State Univ., Corvallis, OR (USA). Dept. of Physics. [1990]. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-87ER40345. Order Number DE90010421. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This grant has as its overall goal the pursuit of on-line nuclear orientation experiments for the purpose of eliciting details of nuclear structure from the decays of neutron-deficient nuclei, such as

those produced by the Holifield Heavy-Ion Research Facility at Oak Ridge and extracted by the UNISOR Isotope Separator. This paper discusses: refrigerator development; the decay of ^{184}Au; the decay of ^{191}Hg to ^{191}Au; the decay of ^{189}Pt to ^{189}Ir; the decays of ^{109,111}Pd; the decay of ^{172}Er; and solid angle corrections.

31834 (INDC(NDS)–232/L, pp. 45-59) **Neutron induced reaction cross-sections on ^{115}In at around 14 MeV.** Csikai, J. (Kossuth Lajos Tudomanyegyetem, Debrecen (Hungary). Kiserleti Fizikai Intezet); Lantos, Z.; Buczko, C.M.; Sudar, S. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. Contract 259/86. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

A systematic investigation was carried out on ^{115}In isotope to determine the contribution of different reactions to the total non-elastic cross-section in the 13.43 and 14.84 MeV range. All the major component cross-sections of σ_{NE} were measured with exception of the σ^{g}(n,n'). In the knowledge of σ_{NE}, the energy dependence of σ^{g}(n,n') could be deduced. The isomeric cross section ratios both for (n,2n) and (n,n') processes were also determined in the given energy range. The present experiment proves the dependence of $\sigma^{m}/(\sigma^{g}+\sigma^{m})$ ratio on the spin value (I_m) of the isomeric state in (n,2n) reaction. Excitation functions of (n,2n), (n,n') and (n,ch) reactions were compared with results calculated by STAPRE code. (author). 37 refs, 5 figs, 4 tabs.

31835 (INDC(NDS)–232/L, pp. 61-67) **Activation cross sections related to nuclear heating of high T_c superconductors.** Csikai, J. (Kossuth Lajos Tudomanyegyetem, Debrecen (Hungary). Kiserleti Fizikai Intezet); Buczko, C.M.; Pepelnik, R.; Agrawal, H.M. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. Contract 259/86;Contract 144/88. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Activation cross-sections have been measured for some isotopes of the elements in $Tl_2Ca_1Ba_2Cu_2O_8$ high T_c superconducting oxide. In addition, cross-sections for producing long-lived isotopes in Cu and Ag were also determined. Results for the following reactions were given at E_n = 14.5 MeV: ^{63}Cu(n,α)^{60g}Co, ^{90}Zr(n,2n)^{89}Zr, ^{107}Ag(n,2n)^{106m}Ag, ^{109}Ag(n,2n)^{108m}Ag, ^{134}Ba(n,2n)^{133g}Ba, ^{134}Ba(n,p)^{134g}Cs, ^{136}Ba(n,p)^{136}Cs, ^{137}Ba(n,p)^{137}Cs and ^{203}Tl(n,2n)^{202}Tl. Results are compared to the corresponding data published in the literature and given by systematics. (author). 9 refs, 1 fig., 2 tabs.

31836 (INP–1344/PS, pp. 296-300) **Excitation of the Giant Dipole Resonance built on highly excited states in ^{114}Sn.** Stolk, A. (Amsterdam Univ. (Netherlands)); Hesselink, W.H.A.; Penninga, J.; Verheul, H.; Balanda, A.; Sujkowski, Z. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The decay of the Giant Dipole Resonance imposed on highly excited states was studied using the ^{110}Cd(α,γ)^{114}Sn capture reaction. 2 refs., 2 figs. (author).

31837 (INP–1344/PS, pp. 316-321) **"All" states in ^{143}Nd.** Wrzesinski, J. (Institute of Nuclear Physics, Cracow (Poland)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

In order to improve the spectroscopic information we performed the detailed investigation of ^{143}Nd excitations using the (α,n,γ) reaction. The beam of energy between 14 and 21 MeV from the FN tandem of the University of Cologne was used to study ^{140}Ce(α,n)^{143}Nd reaction by standard in-beam gamma ray and electron spectroscopy methods. They included the excitation function, angular distribution, gamma-gamma coincidence and conversion electron measurements. 7 refs., 5 figs. (author).

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 31833, 31870

31838 (CONF-891044–10) **On the production of a beam of the long-lived 16$^+$ isomer in hafnium-178.** Kutschera, W. (Argonne National Lab., IL (USA)); Ahmad, I.; Childs, W.J.; Janssens, R.V.F.; Pardo, R.C.; Mausner, L.F. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 1. international conference on radioactive nuclear beams; Berkeley, CA (USA); 16-18 Oct 1989. Order Number DE90009720. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The long-lived high-spin isomer of ^{178}Hf, with $T_{1/2}$ = 31 y and I^{π} = 16$^+$, presents a unique opportunity for a projectile and/or target in nuclear and atomic physics. Various aspects in using ^{178m}Hf for this purpose are discussed in this paper. One possible production mode, the irradiation of Ta with protons, was investigated. Cross sections of ~40 and ~200 μb were found for proton energies of 46 and 92. 5 MeV, respectively. First ideas for a possible isomeric enrichment procedure by selective laser deflection are presented. 14 refs., 3 figs., 1 tab.

31839 (INDC(NDS)–232/L, pp. 33-41) **Research of activation cross sections for long-lived radionuclides on elements of Cu, Mo, Ag, Eu and Tb.** Lu Hanlin (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy); Yu Weixiang; Zhao Wenrong. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The cross sections for ^{109}Ag(n,2n)^{108m}Ag, ^{151}Eu(n,2n)^{150m}Eu, ^{153}Eu(n,2n)^{152g}Eu and ^{159}Tb(n,2n)^{158}Tb reactions have been measured by the activation method at 14 MeV. The results were compared with existing data and calculations of systematic and Code HFTT which was based on the compound nucleus evaporation model and the preequilibrium exciton model. (author). 14 refs, 6 figs, 4 tabs.

31840 (INDC(NDS)–232/L, pp. 43) **Radiochemical studies of fast neutron induced long-lived activation products.** Qaim, S.M. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemie 1 - Nuklearchemie). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Short communication. COPPER 63 TARGET/neutron reactions; EUROPIUM 151 TARGET/neutron reactions; TERBIUM 159 TARGET/neutron reactions; CROSS SECTIONS; EUROPIUM 150; MEV RANGE 01-10; MEV RANGE 10-100; NEUTRONS; NICKEL 63; PROTONS; TERBIUM 158

31841 (INDC(NDS)–232/L, pp. 69-77) **Measurements of 14-MeV neutron cross-sections for the production of isomeric states in hafnium isotopes.** Patrick, B.H. (UKAEA Harwell Lab. (UK). Nuclear Physics and Instrumentation Div.); Sowerby, M.G.; Wilkins, C.G.; Russen, L.C. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The cross sections for the production of isomeric states in the reactions ^{179}Hf(n,2n)^{178m2}Hf, ^{180}Hf(n,2n)^{179m2}Hf, ^{179}Hf(n,n')^{179m2}Hf with 14 MeV neutrons have been measured and compared with the theoretical ones. 4 refs, 3 figs, 4 tabs.

31842 (INDC(NDS)–232/L, pp. 79-86) **A search for long-lived radionuclides produced by fast-neutron irradiations of copper, silver, europium, terbium, and hafnium.** Meadows, J.W. (Argonne National Lab., Argonne, IL (USA). Engineering Physics Div.); Smith, D.L.; Greenwood, L.R.; Haight, R.C.; Ikeda, Y.; Konno, C. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. Contract W-31-109-Eng-38;Contract W-7405-Eng-36. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Identical sample packets, each containing samples of elemental copper, silver, europium, terbium, and hafnium, as well as titanium, iron and nickel as dosimeters, have been irradiated in three distinct accelerator neutron fields (at Argonne National Laboratory and Los Alamos National Laboratory in the U.S.A., and Japan Atomic Energy Research Institute, Tokai, Japan) as part of an interlaboratory research collaboration to search for the production of long-lived radionuclides for fusion waste disposal applications. This paper is a progress report on this project. To date, we have detected the following activities, and have obtained preliminary experimental cross section values for several of these: Ag-106m,108m,110m; Eu-150m,152g,154; Tb-158,160; and Hf-175,178m2,179m2,181. (author). 11 refs, 1 fig., 4 tabs.

31843 (INDC(NDS)–232/L, pp. 87-94) **Measurements of cross sections of the ^{109}Ag(n,2n)^{109m}Ag, ^{151}Eu(n,2n)^{150}Eu, and ^{153}Eu(n,2n)^{152}Eu reactions at neutron energy 14 MeV.** Blinov, M.V. (Radievyj Inst., Leningrad (USSR)); Filatenkov, A.A.; Shirvaev, B.M.; Chuvaev, S.V. International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The cross sections of the reactions producing long-lived nuclides: ^{108}Ag, ^{150}Eu, and ^{152}Eu have been measured at neutron energy about 14 MeV. An activity of irradiated samples was measured with a Ge(Li)-detector. Isotopically pure samples were used. (author). 10 refs, 3 figs, 3 tabs.

31844 (INP–1344/PS, pp. 45-73) **High-spin structure of light Hf isotopes.** Huebel, H. (Bonn Univ. (Germany, F.R.). Inst. fuer Strahlen- und Kernphysik). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

High-spin states in the light Hf isotopes $^{160-166}$Hf have been investigated by in-beam γ-ray spectroscopy using Compton-suppressed Ge detectors. States up to $I > 30\,\hbar$ could be identified from the discrete line spectroscopy. With similar statistical accuracy for both nuclei, ^{164}Hf and ^{166}Hf, states up to similar spins ($\approx$32) could be identified in the negative parity sequences, but in the positive parity sequence much higher spin states (up to $\approx 38^+$) were found in ^{166}Hf than in ^{164}Hf (up to 28^+). A change in structure with irregular non-rotational level spacings and a splitting of the intensity into two (or more) branches might occur around spin 28^+ in ^{164}Hf. The negative parity sequences become yrast at the highest spins in this nucleus. A critical frequency of $\approx$0.42 MeV for the $h_{11/2}$ proton alignment is calculated within the CSM for all even light Hf isotopes, but experimentally this alignment is only observed for ^{162}Hf and ^{166}Hf in this frequency region. 8 refs., 13 figs. (author).

31845 (INP–1344/PS, pp. 74-99) **The effect of triaxiality and γ softness on the structure of the Re-Os nuclei.** Lieder, R.M. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik); Gast, W.; Hebbinghaus, G.; Kraemer-Flecken, A.; Skalski, J.; Urban, W.; Kluge, H.; Maier, K.H.; Sletten, G.; Garrett, J.D. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Experimental information about triaxial and soft shapes for the Os nuclei has been presented. It comprises the observation of low-lying and staggering γ bands, signature splitting in bands involving $i_{13/2}$ quasi neutrons, the crossing of the positive-parity yrast band by a negative-parity sequence and high-spin K isomers with extremly small K hindrance factors. Considering all the evidence it may be concluded that the Os nuclei have γ deformations between $\gamma \approx -10^0$ and $\approx -20^0$ and that they are γ soft. 43 refs., 14 figs. (author).

31846 (INP–1344/PS, pp. 153-173) **Gamma-ray continuum and the structure of ^{153}Ho at very high spin.** Radford, D.C. (Atomic Energy of Canada Ltd., Chalk River, ON (Canada). Chalk River Nuclear Labs.). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The discrete level scheme of ^{153}Ho, as an illustration of how well we believe we understand the single-particle configurations of such nuclei, is briefly presented. A precise measurement of the complete γ-ray spectrum from the ^{120}Sn(^{37}Cl,4n)^{153}Ho reaction and the implications of some of the results are described in some details. Preliminary results of a quasicontinuum measurement in ^{152}Dy, from which we are able to extract quantitative information on the lifetime of states contributing to the "E2 bump" are presented. Lastly, a brief description of the 8π spectrometer, a large multi-detector system for γ-ray spectroscopy nearing completion at Chalk River is given and some of the prospects such instruments hold for future experiments of this type are indicated. 18 refs., 11 figs. (author).

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

Refer also to citation(s) 31778, 31828, 31833

31847 (INP–1344/PS, pp. 308-315) **Isomers in polonium nuclei.** Maj, A. (Institute of Nuclear Physics, Cracow (Poland)).

Cracow-West Berlin-Bonn-Oslo-Livermore Collaboration. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The ^{198,200}Po nuclei are studied in order to see possible onset of collectivity or deformation. The experiments have been performed including γ–γ coincidences, conversion electrons, g-factor and quadrupole moment measurements. Both nuclei possess 3 isomers. Examples of spectra and obtained partial levels schemes are presented. 8 refs., 8 figs. (author).

31848 (INP–1344/PS, pp. 322-327) **Shape coexistence in lead isotopes.** Penninga, J. (Vrije Univ., Amsterdam (Netherlands). Natuurkundig Lab.); Balanda, A.; Hesselink, W.H.A.; Stolk, A.; Verheul, H.; Klinken, J. van; Riesebos, H.J.; Voigt, M.J.A. de. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

A main goal of this work is the search for a proof of shape coexistence in lead isotopes. 7 refs., 3 figs. (author).

31849 **Superdeformed band in ^{192}Hg.** Ye, D.; Janssens, R.V.F.; Carpenter, M.P.; Moore, E.F.; Chasman, R.R.; Ahmad, I.; Beard, K.B.; Benet, P.; Drigert, M.W.; Fernandez, P.B. *Physical Review, C (Nuclear Physics) (USA),* 41(1): R13-R16 (Jan 1990). DOE Contract W-31109-ENG-38.

The observation of a superdeformed band in the nucleus ^{192}Hg is reported. The band has sixteen transitions with an average energy spacing of 36 keV and an average dynamic moment of inertia $\mathcal{J}^{(2)}$ of 112 $\hbar^2$ MeV^{-1}. This band persists to rather low rotational frequency ($\hbar\omega\sim$0.125 MeV) and is proposed to extend in spin from 10$^+$ to 42$^+$. No transitions linking the superdeformed states and the low deformation yrast levels were found and the decay out of the superdeformed band appears to be statistical. This is the second case of superdeformation in the $A\sim$190 region.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 31871

31850 (DOE/ER/40475–3) **Fission cross section measurements of Cm-247, Cf-250 and Es-254 from 0.1 eV to 80 keV.** Danon, Y. (Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics); Slovacek, R.E.; Block, R.C.; Lougheed, R.W.; Hoff, R.W.; Moore, M.S. Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Nuclear Engineering and Engineering Physics. [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40475;W-7405-ENG-48. (CONF-900608–16: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90010050. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Fission cross section measurements were made with the RINS system over the neutron energy range from approximately 0.1 eV to 80 keV upon samples of Cm-247, Cf-250 and Es-254. The Cm-247 measurement was undertaken to complete the RINS fission cross section measurement sequence of the curium isotopes, Es-254 was measured because it is a very heavy odd-odd nucleus which might show interesting nuclear structure effects in its fission cross section, and Cf-250 was measured to account for its buildup as a daughter product from the 276-day halflife Es-254. 6 refs., 3 figs.

31851 (INP–1344/PS, pp. 191-220) **The positron puzzle or what we know about positron production in heavy ion collisions.** Bokemeyer, H. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)). EPOS Collaboration. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

I will concentrate on the respective EPOS-experiment, which in addition to various positron lines recently also established a correlated electron positron emission with both the electron- and positron-line at comparable energy. The EPOS system, an electron-positron solenoid spectrometer installed at the UNILAC accelerator, combines for positrons and electrons both transported in a solenoidal field to appropriate Si(Li) detectors, the advantages of wide momentum band characteristics, large efficiency and high energy resolution in the Si(Li)-counters. Positrons and electrons are recorded event by event principially in coincidence with the scattered heavy ions. With the installation of positron-sensitive parallel-plate heavy-ion avalanche counters, the spectrometer offers the possibility of determining the collision kinematics from a measure of the ion scattering angles (θ,ϕ), the difference of their time of flight, and the ion's energy loss. 59 refs., 12 figs. (author).

31852 (INP–1344/PS, pp. 338-342) **Backward Z = 1 particle emission in the reaction ^{3}He + ^{238}U at intermediate energies.** Skulski, W. (Warsaw Univ. (Poland)); Fatyga, M.; Karwowski, H.; Kwiatkowski, K.; Viola, V.E.; Hicks, K. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The central and the peripheral reaction mechanisms are studied in the case of ^{3}He + ^{238}U reaction. The fission fragment folding angle θ_{AB} in coincidence with light charged particles (LCP) at intermediate beam energies is measured. The attention is focused on the Z = 1 LCP emission in a backward LAB direction. 3 refs., 2 figs., 1 tab. (M.F.W.).

31853 **Actinide cross sections from the reaction of ^{13}C with ^{254}Es^g.** Moody, K.J. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94551 (US)); Lougheed, R.W.; Dougan, R.J.; Hulet, E.K.; Wild, J.F.; Summerer, K.; Hahn, R.L.; Aarle, J.v.; Bethune, G.R. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 152-159 (Jan 1990). DOE Contract W-7405-ENG-48.

We have measured cross sections for the formation of actinide transfer products in the reaction of 72-MeV ^{13}C projectiles with ^{254}Es^g targets. The pattern of nuclide yields is similar to those observed in the reactions of heavier ions with ^{254}Es^g. We have constructed the primary element yields from these results and show that the total cross section for transfer reactions is 58 mb. The total reaction cross section is about 300 mb. Lawrencium isotopes are formed with larger cross sections than are consistent with the trends of the transfer-product distributions; we explain this in terms of massive transfer, and model the lawrencium yields with an evaporation code.

6530 Nuclear Theory

Refer also to citation(s) 31820, 31831, 31847, 31851

31854 (BONN-ME–90-01) **Integrodifferential equation approach. Pt. 1. Triton and α-particle binding energies.** Oehm, W. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.); Sofianos, S.A.; Fiedeldey, H.; Fabre de la Ripelle, M. Bonn Univ. (Germany, F.R.). Physikalisches Inst. Feb 1990. 43p. Order Number DE90784938. Available from NTIS (US Sales Only), PC A03/MF A01.

A single integrodifferential equation in two variables, valid for A nucleons interacting by pure Wigner forces, which has previously only been solved in the extreme and uncoupled adiabatic approximations is now solved exactly for three- and four-nucleon systems. The results are in good agreement with the values obtained for the binding energies by means of an empirical interpolation formula. This validates all our previous conclusions, in particular that the omission of higher (than two) order correlations in our four-body equation only produces a rather small underbinding. The integrodifferential equation approach (IDEA) is here also extended to spin-dependent forces of the Malfliet-Tjon type, resulting in two

coupled integrodifferential equations in two variables. The exact solution and the interpolated adiabatic approximation are again in good agreement. The inclusion of the hypercentral part of the two-body interaction in the definition of the Faddeev-type components again leads to substantial improvement for fully local potentials, acting in all partial waves. (orig.).

31855 (DOE/ER/40154–3) **Research in theoretical nuclear physics: [Progress report].** Liu, Keh-Fei. Kentucky Univ., Lexington, KY (USA). 13 Sep 1989. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-84ER40154. Order Number DE90010792. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses: the role of nuclear binding in EMC effect; skyrmion quantization and phenomenology; lattice gauge Monte Carlo calculations; identification of tensor glueball; evidence of mesoniums in $\bar{p}m$ annihilation and $\gamma\gamma$ reactions; Skyrme-Landau parameterization of effective NN interactions; and quark-gluon plamsa. (LSP)

31856 (DOE/ER/40427–28-N9) **Strong coupling QCD and the (π^+,π^-) reaction.** Miller, G.A. (TRIUMF, Vancouver, BC (Canada)). Washington Univ., Seattle, WA (USA). Dept. of Physics. [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER40427. (CONF-8908131–5: 2. LAMPF workshop on pion-nucleus double charge exchange, Los Alamos, NM (USA), 9-11 Aug 1989). Order Number DE90010425. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Previous six-quark bag model calculations are in disagreement with new (π^+, π^-) data, but conventional nucleonic calculations are generally successful. Six-quark bag models are related to perturbative QCD. I argue that the strong coupling limit of QCD (SCQCD) is a more appropriate starting point for nuclear physics. 15 refs., 3 figs.

31857 (DOE/ER/40427–31-N9) **Chiral symmetry and charge symmetry.** Henley, E.M. Washington Univ., Seattle, WA (USA). Dept. of Physics. [1989]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER40427. (CONF-890979–3: Fundamental symmetries in nuclei and particles, Pasadena, CA (USA), 7-9 Sep 1989). Order Number DE90010426. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The interconnection of charge symmetry and chiral symmetry breaking are discussed. Some consequences of a partial restoration of chiral symmetry in nuclei is brought out by means of the Nambu-Jona-Lasinio model. 22 refs., 10 figs.

31858 (EGG–2589) **COMBINE/PC: A portable ENDF/B Version 5 neutron spectrum and cross-section generation program.** Grimesey, R.A.; Nigg, D.W.; Curtis, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1990. 122p. Sponsored by U.S. DOE Energy Research; U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90008239. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

COMBINE/PC is a FORTRAN 77 code that calculates neutron spectra and ENDF/B Version 5-based neutron cross sections. The program is capable of handling a wide variety of practical fission and fusion-related applications, while remaining machine-independent. The energy range treated extends from 0.001 eV to 16.905 MeV. The calculations in the fast and epithermal energy range are based on extensive modification and reprogramming of the GAM code. COMBINE/PC incorporates superior methods of performing both the resolved and unresolved resonance calculations. This code includes a routine to calculate a Dancoff-Ginsburg correction factor in conjunction with the resonance calculation for either a rectangular or hexagonal arrangement of cylindrical fuel rods. In the thermal energy range, COMBINE/PC solves for the neutron spectrum using an iterative solution to the integral formulation of the neutron thermalization problem. The fast and thermal energy ranges are coupled using slowing down theory to generate scatter sources into the thermal energy range. An option to self-shield cross sections in the thermal energy range using the Amouyal/Benoist/Horowitz method is available. COMBINE/PC generates output multigroup macroscopic and microscopic cross sections for all materials in the calculation using standard flux-weighting techniques. The multigroup cross sections may be output in any of several standard formats including ANISNB 14-- free format, CCCC ISOTXS format, and AMPX working library format. 46 refs.

31859 (INDC(NDS)–232/L, pp. 95-98) **Status of theories for calculations of production cross sections of long-lived radionuclides.** Fu, C.Y. (Oak Ridge National Lab., TN (USA)). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Jan 1990. Contract DE-AC05-84OR21400. (CONF-8909268–: IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology, Argonne, IL (USA), 11-14 Sep 1989). In *Activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology: Proceedings of an IAEA consultants' meeting held at Argonne National Laboratory, Argonne, Illinois, USA 11-12 September 1989.* Order Number DE90625883. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Topics included in this paper are the optical model, gamma-ray strength function, total and exciton level-density theories and the pre-compound model used for the calculation of neutron activation cross sections. 14 refs.

31860 (INP–1344/PS) **Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April 1986: Part 1. Selected topics in nuclear structure.** Broda, R.; Stachura, Z. (eds.). Institute of Nuclear Research, Warsaw (Poland). 1986. 373p. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The report contains 14 lectures and 14 papers. High spin physics and heavy ion reaction mechanisms are mainly discussed. (M.F.W.).

31861 (INP–1344/PS, pp. 15-44) **Correlations in rapidly-rotating nuclei.** Garrett, J.D. (Niels Bohr Inst., Copenhagen (Denmark)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Two current high-spin topics are discussed: the competition between collective and single-particle configurations and correlations at large angular momentum. For both topics some data are briefly considered but mostly the physical consequences are studied. 72 refs., 16 figs. (author).

31862 (INP–1344/PS, pp. 100-111) **Quarks in nuclei.** Irvine, J.M. (Manchester Univ. (UK). Dept. of Physics). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

There is a distinction between the physicists who practice particle physics and nuclear physics. The nuclear physicists think that the structure of nuclei and their interactions can be interpreted in terms of interacting sets of nucleons. The more adventurous may allow a few pions to enter and the trully heretical may even consider the excitation of the nucleon into the Δ (1232) state. The particle physicist on the other hand knows as a fact that the nucleus can only be understood in terms of QCD, i.e. quarks and gluons. I shall review the evidence in favour of these two points of view in this lecture. 1 fig. (author).

31863 (INP–1344/PS, pp. 112-119) **MONSTER and VAMPIR: an approach to the exact shell-model.** Gruemmer, F. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik); Schmid, K.W.; Hammaren, E. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number

DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

General microscopic nuclear structure models are discussed, which are mixtures of configuration mixing models and mean field approximations. For each of them applications in realistic cases will be shown. Their particular advantages and successes as well as their inherent limitations will be discussed in detail. 20 refs., 4 figs. (author).

31864 (INP–1344/PS, pp. 135-152) **"Mean field theory of nuclear spin".** Doenau, F. (Zentralinstitut fuer Kernforschung, Rossendorf (German Democratic Republic)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Nuclear deformation is an outstanding example of spontaneous symmetry breaking in quantal many body systems concerning in this case the global rotational invariance. The proposed theory for restoring this symmetry starts basically on the Cranking concept though contrary to the common Cranking approaches the Cranking axis is not fixed along a selected principal axis of the deformed shape but all possible Cranking directions are taken into account. In this way also the mean value of the angular momentum vector may point in arbitrary directions relative to the intrinsic system. The orientation of the nuclear spin is studied as a collective degree of freedom. Treating the two angles defining this orientation as generator coordinates the potential energy surface can be constructed. Adding to it a kinetic energy term the collective Hamiltonian of this motion is found and its quantization is performed. The theory provides a new theoretical basis for calculating the properties of rotating deformed nuclei. It is applicable to the case of complex quasiparticle configurations in even-even, in odd as well as in odd-odd nuclei irrespectively whether the shape is axially or triaxially deformed. The nuclear wave function is a superposition of determinatal states that belong to the various spin orientations of a given spin value. This representation can be directly used to construct the transition amplitudes of the electromagnetic radiation which is highly desirable with respect to the interpretation of high spin data measured with modern multidetector spectrometers. (author).

31865 (INP–1344/PS, pp. 174-190) **Nuclear structure studies "off-stability".** Grawe, H. (Hahn-Meitner-Institut Berlin GmbH (Germany, F.R.)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

I will demonstrate the application of multi-detector-arrays and hyperfine interaction methods in the spectroscopy of spherical nuclei close to the proton dripline and the doubly magic ^{100}Sn and of the transitional translead nuclei with $N < 126$, where we are approaching a new region of deformation and the fissility line. 23 refs., 5 figs. (author).

31866 (INP–1344/PS, pp. 120-134) **A new approach to the microscopic theory of nuclear reactions.** Schmid, K.W. (Tuebingen Univ. (Germany, F.R.). Inst. fuer Theoretische Physik); Fladt, B.; Gruemmer, F. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

We present a new approach to the microscopic description of photonuclear reactions with real and virtual photons as well as of elastic and inelastic nucleon-nucleon scattering. The model (MERLIN Monster approach to Electromagnetic Reactions and Low energy Inelastic Nucleon scattering) is based on MONSTER (VAMPIR) nuclear structure wave functions, which are calculated in a large single particle modelspace including all single particle resonances as quasibound basis orbitals and then embedded in the remaining, resonance-free continuum. Because of the complexity of the underlying nuclear structure description, thus effects of more than one nucleon in the continuum can be accounted for at least approximately. Consequently besides the gross structure also intermediate and fine structures of the nuclear response can be studied. A first application of the model is presented and possible extensions are discussed. 9 refs., 4 figs. (author).

31867 (INP–1344/PS, pp. 221-224) **Collective properties of nuclei in the radium region.** Boening, K. (Institute for Nuclear Studies, Otwock-Swierk (Poland)); Patyk, Z.; Sobiczewski, A. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The calculations of octupole-transition probability $B(E_3)$ for low-energy collective states of an even-even nucleus are performed. The quadrupole-transition probabilities $B(E_2)$ are also considered. 8 refs., 2 figs. (author).

31868 (INP–1344/PS, pp. 273-276) **The quadrupole and hexadecapole moments of nuclei in the generator coordinate method.** Nerlo-Pomorska, B. (Regensburg Univ. (Germany, F.R.). Naturwissenschaftliche Fakultaet 2 - Physik); Pomorski, K.; Brack, M.; Werner, E. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Collective quadrupole and haxadecapole moments of the light even-even rare-earth nuclei derived within the the generator coordinate method are compared with the experimental data. 6 refs., 2 figs. (M.F.W.).

31869 (INP–1344/PS, pp. 277-279) **Interplay between the octupole and nonaxial degrees of freedom at high spins in actinide nuclei.** Cwiok, S. (Institute of Technology. Institute of Physics, Warsaw (Poland)); Nazarewicz, W.; Briancon, Ch.; Dudek, J. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

In this contribution we would like to announce new systematic calculations of the total energy surfaces for the $88 < Z < 96$ nuclei at various spin regimes. 10 refs., 1 fig. (author).

31870 (INP–1344/PS, pp. 225-245) **The compound nucleus angular momentum distribution following fusion.** Leigh, J.R. (Australian National Univ., Canberra (Australia). Research School of Physical Sciences); Bokhorst, J.J.M.; Chatterjee, A.; Hinde, D.J.; Newton, J.O.; Ogaza, S.; Kondo, Y.; Robson, B.A. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

Measurements of fusion, fission and elastic scattering cross sections have been made for a series of reactions using ^{18}O and ^{19}F projectiles. The results are all consistent with diffuse angular momentum distributions following fusion, even at energies well above the fusion barrier. Preliminary γ-ray multiplicity measurements support this conclusion. The interpretation of fission data for the ^{124}Sn + ^{58}Ni reaction suggests much more dramatic smearing of the spin distributions associated with heavier projectiles. 22 refs., 7 figs. (author).

31871 (INP–1344/PS, pp. 280-295) **Radioactive decay by the emission of nuclei heavier than alpha particles.** Blocki, J. (Institute for Nuclear Studies, Otwock-Swierk (Poland)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In

Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure. Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The branching ratios of the lifetimes for the radioactive decay of nuclei by the emission of alpha particles and heavier nuclei like ^{14}C are estimated. Calculations are based on the idea that these decay modes can be treated as extremely asymmetric fissions. The potential barriers are calculated as a Coulomb potential plus Yukawa plus exponential folded potential. The comparison with a recently observed branching ratios between alpha particle decay and ^{14}C emission from ^{222}Ra, ^{223}Ra and ^{224}Ra shows that the agreement is within one order of magnitude. 7 refs., 5 figs., 2 tabs. (author).

31872 (INP–1344/PS, pp. 343-345) **Semiclassical nuclear many-particle many-hole level densities.** Blin, A.H. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Lab. de Physique Nucleaire); Hasse, R.W.; Hiller, B.; Schuck, P. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

An exact general scheme is decribed to calculate the m-particle n-hole fermion level densities for an arbitrary single particle Hamiltonian taking into account the Pauli exclusion principle. This technique is applied to obtain level densities of the three dimensional isotropic harmonic oscillator semiclassically in the Thomas-Fermi approach. In addition, we study the 1-particle 1-hole level density of the Woods-Saxon potential. For the harmonic oscillator we analyze the temperature dependence of the linear response function and the influence of pairing correlations. 2 refs., 2 figs. (author).

31873 (INP–1344/PS, pp. 301-307) **Damping of giant Gamow-Teller resonances: central versus tensor correlations.** Drozdz, S. (Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The decay properties of nuclear giant Gamow-Teller resonances are discussed in the framework of the second-order RPA. The effective interaction used is based on a Brueckner G-matrix. This interaction in the extended model space gives a very reasonable description of the centroid energies as well as of the spreading width of the resonances. The tails of the distributions are mostly produced by central spin-isospin correlations. 12 refs., 5 figs., 1 tab. (author).

31874 (INP–1344/PS, pp. 331-337) **Angular momentum and temperature dependence of Hartree-Fock fission barriers.** Okolowicz, J. (Institute of Nuclear Physics, Cracow (Poland)). Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The fission barriers of a rare earth nucleus have been calculated within extended two-dimensional Hartree-Fock approach. These extensions have accounted for a rotation around an axis perpendicular to the symmetry axis and for a temperature. Critical angular momentum for hot fission is deduced. 12 refs., 3 figs. (author).

31875 (INP–1344/PS, pp. 350-358) **Path integrals in spontaneous fission.** Baran, A. (Uniwersytet Marii Curie-Sklodowskiej, Lublin (Poland). Inst. Fizyki); Lojewski, Z.; Staszczak, A. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure.* Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

The spontaneous fission half life time was calculated using static, dynamic and Monte Carlo methods. 9 refs., 5 figs. (M.F.W.).

31876 (LA-UR–90-1360) **Correlations, nuclear structure, and DCX [double charge exchange].** Kaufmann, W.B. (Los Alamos National Lab., NM (USA)); Gibbs, W.R. Los Alamos National Lab., NM (USA). 9 Aug 1989. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8908131–6: 2. LAMPF workshop on pion-nucleus double charge exchange, Los Alamos, NM (USA), 9-11 Aug 1989). Order Number DE90010603. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

To what extent can we understand current low-energy DCX cross sections to the DIAS in terms of the sequential mechanism? What do the results have to say about the nuclear wave functions? 20 refs., 20 figs.

31877 (UCID–18987-90) **Report to the DOE [Department of Energy] Nuclear Data Committee, 1990.** Resler, D.A.; Jacobs, A.L.; White, R.M. Lawrence Livermore National Lab., CA (USA). Mar 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010184. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper contains nuclear data calculations of a number of thermonuclear fusion reactions. Some of the reactions investigated are: $^{2}H(d,p)^{3}H$; $^{2}H(d,m)^{3}He$; $^{3}H(d,m)^{4}He$; and $^{3}He(d,p)^{4}He$. Also discussed are measurements on limits of neutron emission from "Cold Fusion" in metal hydrides. (LSP)

31878 **Spin observables for polarized proton scattering from polarized ^{3}He.** Landau, R.H. (Physics Department, Oregon State University, Corvallis, Oregon 97331 (US)); Sagen, M.; He, G. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 50-62 (Jan 1990).

Polarization observables for the scattering of two spin-$\frac{1}{2}$ particles are organized into different classes based on the difficulty of their measurement. The large or significantly varying ones are noted. A microscopic, momentum space optical potential is used to predict all polarization observables for 250–650 MeV proton scattering from the ^{3}He nucleus, and the observables are presented in three-dimensional plots.

31879 **Flow effects on transverse momentum spectra in ultrarelativistic nuclear collisions.** Venugopalan, R. (Physics Department, State University of New York at Stony Brook, Stony Brook, New York 11794 (US)); Prakash, M. *Physical Review, C (Nuclear Physics) (USA),* 41(1): 221-225 (Jan 1990). DOE Contract FG02-88ER40388.

We discuss fits of the Landau-Milekhin model to the transverse momentum spectra measured in 200 GeV/*c* nucleus-nucleus collisions. It is observed that the data are fit by a range of anticorrelated values of the breakup temperature and the average transverse hydrodynamic velocity. These fits indicate that a better understanding of transverse flow in ultrarelativistic nuclear collisions is required to uniquely determine the breakup temperature of the system.

31880 **Kaon versus pion interferometry signatures of quark-gluon plasma formation.** Gyulassy, M. (Nuclear Science Division, Mail Stop 70A-3307, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Padula, S.S. *Physical Review, C (Nuclear Physics) (USA),* 41(1): R21-R23 (Jan 1990). DOE Contract AC03-76SF00098.

The advantages of kaon versus pion interferometry as a probe of quark-gluon plasma formation in high energy nuclear collisions are studied by comparing predictions of Lund resonance gas and plasma hydrodynamic models.

6540 Radiation and Shielding Physics

Refer also to citation(s) 30350, 31274, 31280, 31289, 31296, 31305, 31307, 31311

31881 (CTH-RF–67) **Approximate high-order eigenvalues in two-medium, one-speed neutron transport.** Sjoestrand, N.G. Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Reactor

Physics. Nov 1989. 17p. Order Number DE90625701. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Earlier work on high-order criticality eigenvalues in homogeneous systems with neutrons of one speed has been extended to two-medium systems. Reflected spheres as well as reflected infinite slabs and cylinders have been studied. Values from the derived formulae have been compared with numerical results obtained recently by Garis for spheres and slabs. The agreement is generally good. (author).

31882 (LA–11625-MS) **Electron stopping powers of some elements and compounds from 0 to 10,000 eV: A compilation.** Devaney, J.J. Los Alamos National Lab., NM (USA). Jul 1989. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90010675. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Electron stopping powers of hydrogen, helium, nitrogen, oxygen, aluminum, silicon, silicon dioxide, nickel, copper, silver, tungsten, gold, air, collodion, liquid water, polystyrene, polyethylene, aluminum oxide, kaptan, mylar (polyethylene terephthalate), bakelite, lucite, plexiglas (polymethyl methacrylate), perspex, PMMA resist, melinex, and nylon 6,6 are given from 0 to 10,000 eV where available. Ashley's formulae for the stopping power of some organic solids are included. Iskef and Watt's simple formulae are given. The NBS Bethe stopping powers for 51 materials from 1 to 10 keV are reproduced.

31883 A semiempirical nonrelativistic electron straggling distribution function. Antolak, A.J. (Theoretical Division, Sandia National Laboratories, Livermore, California 94551 (US)); Williamson, W. Jr. *Journal of Applied Physics (USA)*, 67(3): 1510-1514 (1 Feb 1990). DOE Contract AC04-76DP00789.

A semiempirical function for the energy-loss distribution of nonrelativistic electrons is presented. The form of the distribution function permits analytic sampling of the energy loss and is, therefore, suitable for Monte Carlo electron transport codes developed for small microprocessor computer systems. Comparisons between calculated transmitted energy distributions using a microprocessor and experimental results are presented for 15–20-keV incident electrons on aluminum, copper, and gold foils.

31884 Multiple scattering of MeV atomic and molecular ions traversing ultrathin films. Zajfman, D. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Both, G.; Kanter, E.P.; Vager, Z. *Physical Review, A (General Physics) (USA)*, 41(5): 2482-2488 (1 Mar 1990). DOE Contract W-31109-ENG-38.

We have investigated the connection between small-angle multiple scattering and charge-changing processes for fast atomic and molecular ions traversing ultrathin solid targets. Results for the atomic ions show a strong target-thickness dependence of the measured final-charge-state distributions. There is also an accompanying dependence of the multiple-scattering widths upon the final charge state of the ions. These results demonstrate conditions far from equilibrium for these processes. A Monte Carlo simulation of particle motion in the foil is described that successfully accounts for these observations. The same simulation is applied to describe the multiple scattering of diatomic molecular ions and to compute the spread of the internuclear velocity after Coulomb explosion. It is found that the Coulomb repulsion tends to reduce multiple-scattering components along the internuclear axis. Consequences for Coulomb-explosion studies of molecular structures are discussed.

31885 Validity of the continuous-slowing-down approximation in electron degradation, with numerical results for argon. Kowari, K. (Argonne National Laboratory, Argonne, Illinois 60439 (US)). *Physical Review, A (General Physics) (USA)*, 41(5): 2500-2505 (1 Mar 1990). DOE Contract W-31109-ENG-38.

The electron degradation spectrum plays a key role in describing the electron slowing-down processes in matter. The validity of a method to obtain the electron degradation spectrum approximately, i.e., the continuous-slowing-down approximation with full accounting of electron production, is examined. Numerical results derived with this method are compared with the direct solution of the Spencer-Fano equation for argon using the same set of electron-collision cross sections. The method is effective at electron kinetic energies much higher than the first ionization threshold but fails at low electron kinetic energies even when the kinetic energy of an incident electron is high. Reasons for this failure are discussed in detail.

6550 Medical Physics

Refer also to citation(s) 31455, 31573, 31643

31886 (CNIC–00254) **Calculations of dosimetric parameter and REM meter response for BE(d, n) source.** Chen Changmao (Academia Sinica, Beijing, BJ (China). Inst. of Atomic Energy). China Nuclear Information Centre, Beijing, BJ (China). 1988. 6p. (In Chinese). (IAE–0066). Order Number DE90626691. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Based on the recent data about neutron spectra, the average energy, effictive energy and conversion coefficient of fluence to dose equivalent are calculated for some Be (α, n) neutron sources which have differene types and structures. The responses of 2202D and 0075 REM meter for thses spectral neutrons are also estimated. The results indicate that the relationship between average energy and conversion coefficient or REM meter responses can be described by simple functions.

31887 (PB–90-163916/XAB) **Report on the 1989 meeting of the Radionuclide Measurements Section of the Consultative Committee on Standards for the Measurement of Ionizing Radiations: Special report on standards for radioactivity.** Hoppes, D.D. National Inst. of Standards and Technology, Gaithersburg, MD (USA). 1989. 4p. Available from NTIS, PC A04.

Included in Jnl. of Research of the National Institute of Standards of Technology, Vol. 94, No. 6, 363-366(1989).

The report describes the activities discussed at the 10th meeting of Section II of the Consultative Committee on Standards for the Measurement of Ionizing Radiations held in May 1989 at Sevres (France). Topics included present and future international comparisons of activity measurements, the status and possible extension of the International reference system for activity measurements of gamma-ray emitting nuclides, reports from other working groups, accomplishments at the International Bureau of Weights and Measures.

31888 Measurement of dose distributions of linear energy transfer in matter irradiated by fast neutrons. Schell, M.C. (Cleveland Clinic Foundation, Department of Radiation Therapy, Cleveland, Ohio 44195 (US)); Pearson, D.W.; DeLuca, P.M. Jr.; Haight, R.C. *Medical Physics (USA)*, 17(1): 1-9 (Jan 1990). DOE Contract AC02-76EV01105;W-7405-ENG-48;W-7405-ENG-36.

A detector has been developed and used to measure dose distributions versus linear energy transfer to thin gas targets in spherical geometry from fast neutron irradiation of tissue-equivalent plastic and carbon. The detector is a hemispherical proportional counter with a Cs(T1) scintillator at the center of the hemisphere. The coincidence of the proportional counter signals constrain the measurements to charged particles traversing the radius of the hemisphere. The charged particle energy deposition distributions are directly measured for a known pathlength. The A-150 kerma factor was measured at a neutron energy of 14.8 MeV and is in agreement with tabulated values. The carbon kerma factor measurements are less than the tabulated value at 14.8 MeV. The alpha-particle production in carbon was measured for neutron energies from 14.1 to 14.8 MeV and is compared with existing data.

6560 Condensed Matter Physics

Refer also to citation(s) 30181, 30622, 30644, 30645, 30647, 30684, 30690, 30726, 30727, 30735, 30741, 30742, 30743, 30744, 30745, 30752, 30756, 30761, 30771, 30775, 30778, 30805, 30806, 30838, 30862, 30864, 30873, 30881, 30907, 31280, 31295, 31321, 31547, 31712, 31716, 31743, 31744

31889 (CBPF-NF–034/89) **A simple model for localized-itinerant magnetic systems: crystal field effects.** Iannarella, L. (Universidade Federal Rural do Rio de Janeiro, RJ (Brazil). Dept. de Fisica); Silva, X.A. da; Guimarares, A.P. Centro Brasileiro de Pesquisas Fisicas (CBPF), Rio de Janeiro, RJ (Brazil). 1989. 15p.

Order Number DE90625399. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The magnetic behavior of a system consisting of localized electrons coupled to conduction electrons and submitted to an axial crystral field at T=0 K is ivestigated within the framework of the molecular field approximation. An analytical ionic magnetic state equation is deduced; it shows how the magnetization depends on the model parameters (exchange, crystal field, band occupation) and external magnetic field. A condition for the onset of spontaneous magnetic order is obtained and the ferro¯ and paramagnetic phases are studied. This study displays several features of real magnetic systems, including quenching or total suppression of the magnetic moments (depending on the relative value of the crystal field parameter) and exchange enhacement. The relevance of such model for the description of rare-earth intermetallic compounds is discussed. (author).

31890 (CEA-CONF–9953) **Channeling effects applied to Auger surface analysis.** Maurice, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-Sur-Yvette (FR). Dept. de Technologie); Legressus, C.; Akamatsu, B.; Henoc, P.; Raouadi, K. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie. 1989. 4p. (CONF-8908226–: 12. International Congress on X-ray Optics and Microanalysis, Cracow (Poland), 28 Aug - 1 sep 1989). Order Number DE90784605. Available from NTIS (US Sales Only), PC A02/MF A01.

We propose a new Auger analysis to study the outer crystalline sublayers of a sample. The method is based on the measurement of contrast due to crystalline effects.

31891 (CONF-900140–22) **State-to-state inelastic and reactive molecular beam scattering from surfaces.** Lykke, K.R. (Argonne National Lab., IL (USA)); Kay, B.D. Argonne National Lab., IL (USA). [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990. Order Number DE90010492. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Resonantly enhanced multiphoton ionization (REMPI) laser spectroscopic and molecular beam-surface scattering techniques are coupled to study inelastic and reactive gas-surface scattering with state-to-state specificity. Rotational, vibrational, translational and angular distributions have been measured for the inelastic scattering of HCl and N_2 from Au(111). In both cases the scattering is direct-inelastic in nature and exhibits interesting dynamical features such as rotational rainbow scattering. In an effort to elucidate the dynamics of chemical reactions occurring on surfaces we have extended our quantum-resolved scattering studies to include the reactive scattering of a beam of gas phase H-atoms from a chlorinated metal surface M-Cl. The nascent rotational and vibrational distributions of the HCl product are determined using REMPI. The thermochemistry for this reaction on Au indicates that the product formation proceeding through chemisorbed H-atoms is slightly endothermic while direct reaction of a has phase H-atom with M-Cl is highly exothermic (ca. 50 kcal/mole). Details of the experimental techniques, results and implications regarding the scattering dynamics are discussed. 55 ref., 8 fig.

31892 (LA–11641-MS) **State of an adiabatic expanding and condensing vapor or slow, medium, and fast explosions into a vacuum.** Strobel, G.L. (Los Alamos National Lab., NM (USA)). Los Alamos National Lab., NM (USA). Apr 1990. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90010815. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A hot dense vapor expanding adiabatically into a vacuum is studied, A condensed phase develops after saturation and supercooling conditions have been achieved. The final state of the system consists of liquid drops in a expanding, cooling vapor. The final condensed mole fraction depends on the drop growth rate compared to the fractional volume rate of expansion at the time saturation is achieved. Drops are produced by a nonequilibrium collision process during supercooling of the vapor. The dependence of the number of drops on various factors is established. The First Law of Thermodynamics is used to solve for the evolution of the system, assuming the volume expansion rate is known. The initial vapor can include an inert gas that does not condense in the temperature range of interest. The vapors are treated as ideal gases until saturation occurs. Slow expansions result in the highest condensed mole fractions. Slow expansions are the result of one-dimensional versus three-dimensional expansions and from saturation occurring at high temperatures and densities. The size per drop depends mostly on how many drops are formed in the nonequilibrium supercooling process. 9 refs., 23 figs., 2 tabs.

31893 (LAMP–89/2) **The characters of slab lasers.** LAMP series report (Laser, Atomic and Molecular Physics). Lu Xuanhui; Wang Shaomin. International Centre for Theoretical Physics, Trieste (Italy). Oct 1989. 13p. Order Number DE90625397. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A viewpoint of Zig-Zag slab lasers having intrinsic pseudoconjugate properties due to total internal reflection is proposed and demonstrated. The compensating ability of slab laser against the optical distortion is analysed. The modes of slab solid-state lasers are derived by a new concept. Fundamental, high-order transverse modes, beam divergences and diffraction loss are remarkable differences in different directions. However, longitudinal modes are asymmetrical standing waves. (author). 13 refs, 4 figs.

31894 (LA-UR–90-1275) **Droplet shattering, vaporization and recondensation in cloud clearing with long pulse infrared chemical lasers.** Caramana, E.J.; Kindel, J.L.; Morse, R.L.; Quigley, G.P.; Webster, R.B.; York, G.W. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900189–1: 1989/90 conference on cloud impacts on DOD operations and systems, Monterey, CA (USA), Jan 1990). Order Number DE90010584. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Results of experimental attempts to produce an optically clear channel in a water cloud by evaporating the cloud droplets with a CO_2 laser are presented. Using scattered light it is possible to visualize the clear channel produced. Measurements of the fraction of power transmitted through the channel at visible wavelengths give insight into the clearing mechanisms. The present data suggest that the water droplets explode in the process of clearing. A theoretical explanation of why this should occur is presented and predictions of the onset of droplet explosions are made. 4 refs., 5 figs.

31895 (LA-UR–90-1354) **Molecular crystals and localized vibrational states.** Migliori, A. (Los Alamos National Lab., NM (USA)); Clogston, A.M.; Hill, J.R.; Moore, D.S.; McDowell, H.K.; Maxton, P.M. Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-8907189–1: NATO conference on dynamical localization, Lyngby (Denmark), 26 Jul 1989). Order Number DE90010602. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The normal modes arising from a simple linear model of a crystalline solid predict many important properties such as the specific heat, the sound velocity, and the Raman and infrared response. Such a model fails, however, to produce thermal expansion and finite thermal conductivity. The introduction of weak non-linear couplings between the normal modes immediately corrects these simpler problems, while preserving the usual phonon representation of the purely linear system as a useful first approximation for small phonon amplitudes. What we wish to consider here is the next step in the process, taken by keeping the weak non-linearities but introducing large phonon amplitudes. Putting aside, for the moment, the question of how to achieve the necessary amplitudes, we can consider the consequences if certain not unusual conditions obtain which put the phonon equation of motion in correspondence with the non-linear Schrodinger equation. We can then be guided by classical solutions of this equation which predict spontaneous symmetry breaking and vibrational localization. To focus our thoughts, we outline in physical terms the processes leading to the localization of vibrational energy. We use the insight gained to guide our choice of materials, and we describe the measurements we have made to begin the establishment of a

rigourous connection between real solids and the theoretical constructs related to this problem. 16 refs., 9 figs.

31896 (RAL–89-128) **COLETTE users' guide.** Heenan, R.W.; King, S.M.; Osborn, R.; Stanley, H.B. Rutherford Appleton Lab., Chilton (UK). Dec 1989. 71p. Order Number DE90625404. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This guide describes the computer program COLETTE. It has been purposely designed to reduce the small-angle data collected on the ISIS small-angle neutron camera LOQ in an interactive and user-friendly manner. This not only gives the LOQ user an opportunity to inspect data rapidly and comprehensively during the course of an experiment but also provides the instrument scientists with a flexible diagnostic tool with which they can monitor the performance of the instrument. After the experiment is completed, COLETTE may be used to provide the final I(Q) versus Q following subtraction of a sample background run and normalisation to a scattering standard. By limiting the range of azimuthal angles included in the analysis the program may take sections through an anisotropic scattering pattern from an ordered system. A completely two dimensional $I(Q_x,Q_y)$ map may also be generated. (author).

31897 (RAL–89-135) **High energy neutron spectroscopy of crystal field excitations in NpO_2.** Fournier, J.M. (Univ. Joseph Fourier, Grenoble (France)); Blaise, A.; Amoretti, G. Rutherford Appleton Lab., Chilton (UK). Dec 1989. 25p. Order Number DE90625405. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Neutron spectroscopy has been applied to study the crystal field potential in NpO_2. The inelastic scattering cross section shows a broad magnetic peak which is split into two components and is centred at about 55 meV. A quasielastic magnetic signal extending up to about 30 meV is also observed at temperatures below the phase transition at 25 K. The inelastic peak is shown to originate from excitations between the $\Gamma_8^{(2)}$ and $\Gamma_8^{(1)}$ crystal field quartets. Its position is in agreement with the value estimated by scaling the crystal field potential of UO_2 to the Np^{4+} case. Several mechanisms which could be responsible for the observed splitting are discussed. (author).

31898 (UCID–21702) **Perturbation growth by thermal blooming in turbulence.** Karr, T.J.; Morris, J.R.; Chambers, D.H.; Viecelli, J.A.; Cramer, P.G. Lawrence Livermore National Lab., CA (USA). 4 Jan 1989. 87p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90010759. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The stability of a phase-compensated laser beam propagating in a turbulent absorbing fluid is considered. Small-scale transverse optical perturbations from turbulence and noise grow in thermal blooming by two instabilities: the uncompensated stimulated thermal Rayleigh scattering instability, and the closed-loop instability. Linearized perturbation theory is used to calculate the electric field spectrum as a Taylor series in time and as superposition of stable and unstable modes. The method is applicable to fluids with arbitrary parameter variations along the path. Compensated perturbations grow exponentially, and uncompensated ones grow quasi-exponentially. The instability growth is in good agreement with numerical simulations of full nonlinear thermal blooming. If the growth rate exceeds the damping rate from other phenomena then the perturbations grow until limited by nonlinear saturation, at which point the beam is significantly degraded. At saturation the laser beam spontaneously breaks into small-scale transverse structures such as filaments or ribbons. 18 refs., 2 figs.

31899 (UCRL-JC–103629) **Cluster formation in laser-induced ablation and evaporation of solids observed by laser ionization time-of-flight mass spectrometry and scanning tunneling microscopy.** Tench, R.J. (Lawrence Livermore National Lab., CA (USA)); Balooch, M.; Bernardez, L.; Allen, M.J.; Siekhaus, W.J.; Olander, D.R.; Wang, W. Lawrence Livermore National Lab., CA (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48;AC03-76SF00098. (CONF-900466–31: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90010876. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Laser ionization time-of-flight mass analysis (LIMA) used pulses (5ns) of a frequency-quadrupled Nd-YAG laser (266 nm) focused onto spots of 4–100 μm diameter to ablate material, and a reflectron time of flight tube to mass-analyze the plume. The observed mass spectra for Si, Pt, SiC, and UO_2 varied in the distribution of ablation products among atoms, molecules and clusters, depending on laser power density and target material. Cleaved surfaces of highly oriented pyrolytic graphite (HOPG) positioned at room temperature either 10 cm away from materials ablated at 10^{-5} Torr by 1–3 excimer laser (308 nm) pulses of 20 ns duration or 1 m away from materials vaporized at 10^{-8} Torr by 10 Nd-Glass laser pulses of 1 ms duration were analyzed by Scanning Tunneling Microscopy (STM) in air with Å resolution. Clusters up to 30 Å in diameter were observed. 8 refs., 4 figs.

31900 Structure studies of thin amorphous films by synchrotron x-ray absorption and analytical electron microscopy. Heald, S.M. (Brookhaven Nat. Lab., Upton, NY (US)); Tafto, J. pp. 811 of Interfaces, superlattices, and thin films. Dow, J.D.; Schuller, I.K. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8612131–: Materials Research Society symposium on interfaces, superlattices and thin films, Boston, MA (USA), 1-6 Dec 1986).

The authors combine the techniques of EXAFS and XANEX using synchrotron x-rays, and the corresponding techniques using electron energy loss spectroscopy (EXELFS and ELNES) to characterize and study the local atomic arrangement in thin amorphous films. These probes are complementary in that x-rays are best suited for absorption edges above 3 keV and electron energy loss spectroscopy for low energy edges, and thus this combination is very useful for amorphous materials containing both low and high Z elements. They use in addition transmission electron microscopy, electron diffraction, and electron energy loss spectroscopy in the low energy loss region. Results from amorphous $Ti0_2$ and amorphous $Sn0_2$ made by reactive sputtering are presented.

31901 Formation, motion and high-temperature superconductivity of large bipolarons. Emin, D. (Sandia National Lab, Albuquerque, NM (US)). pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC04-76DP00789. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Unlike small (localized) bipolarons, large (mobile) bipolarons can yield bipolaronic superconductivity. The stringent conditions for the formation of large bipolarons as well as distinctive features of the normal-state transport and superconducting-state properties of large bipolarons appear consistent with observations of the high-temperature superconductors.

31902 Density dependence of the momentum distribution in normal liquid ^{4}He. Herwig, K.W. (Department of Physics, The Pennsylvania State University, University Park, Pennsylvania 16802 (USA)); Sokol, P.E.; Sosnick, T.R.; Snow, W.M.; Blasdell, R.C. *Physical Review, B: Condensed Matter (USA),* 41(1): 103-110 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

Deep inelastic neutron scattering measurements on normal liquid ^{4}He at 4.25 K have been carried out at 11 densities between 0.125 (saturated vapor pressure) and 0.200 g/cm^3, at a momentum transfer of 23 A^{-1}. A sum of two Gaussians is required to characterize the scattering at all densities, even when the broadening due to instrumental resolution and corrections to the impulse approximation are included. The kinetic energy varies from 15.5 K at 0.125 g/cm^3 to 32.7 K at 0.200 g/cm^3.

31903 Normal-distortion-mode approach to liquid crystal elastic energy. Schmidt, V.H. (Physics Department, Montana State University, Bozeman, Montana 59717 (US)). *Physical Review Letters (USA),* 64(5): 535-538 (29 Jan 1990). DOE Contract FG06-87ER45292.

It is shown that Frank's "saddle" distortion contribution to the nematic liquid-crystal distortional elastic energy is required, in addition to the splay, twist, and bend energies retained in more recent treatments. "Normal distortion modes" for these four distortions are described. Measurement methods and their interpretations are discussed for the corresponding four elastic constants k_{11} (splay), k_{22} (twist), k_{33} (bend), and k_{44} (saddle). Previously reported values for k_{11} and k_{22} are actually for $k_{11}+k_{44}$ and $k_{22}+k_{44}$ respectively. The Nehring-Saupe molecular approach yields $k_{44}=\frac{1}{2}(k_{11}+k_{22})$.

31904 Binding of holes in the Hubbard model. Dagotto, E. (Institute for Theoretical Physics, University of California, Santa Barbara, California 93106 (USA)); Moreo, A.; Sugar, R.L.; Toussaint, D. *Physical Review, B: Condensed Matter (USA),* 41(1): 811-814 (1 Jan 1990). DOE Contract FG03-85ER45197.

We present a new numerical method for the study of binding energies of particles in fermionic systems. Working with an *imaginary* chemical potential we can obtain results in the *canonical* ensemble by simple modifications of standard numerical techniques. We applied the technique to the two-dimensional Hubbard model observing binding of holes at half-filling on lattices of 4×4 sites. For $U/t=4$ we estimate that the binding energy is $\Delta=-0.10\pm0.02$.

31905 Maximum-entropy method for analytic continuation of quantum Monte Carlo data. Silver, R.N. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Sivia, D.S.; Gubernatis, J.E. *Physical Review, B: Condensed Matter (USA),* 41(4): 2380-2389 (1 Feb 1990).

An outstanding problem in the simulation of condensed-matter phenomena is how to obtain dynamical information. We consider the numerical analytic continuation of imaginary-time quantum Monte Carlo data to obtain real-frequency spectral functions. This is an extremely ill-posed problem similar to the inversion of a Laplace transform. We suggest an image-reconstruction approach, which has been widely applied to data analysis in experimental research. Specifically, we apply the maximum-entropy method (ME) to the analytic continuation of quantum Monte Carlo data. We report encouraging preliminary results for the Fano-Anderson model of an impurity state in a continuum. The incorporation of additional prior information, such as sum rules and asymptotic behavior, can be expected to significantly improve results. We compare (ME) to alternative methods. We also discuss statistical error propagation for the analytic continuation problem via the likelihood function, which is independent of the choice of image-reconstruction method. This includes the sensitivity of the data to structure in the spectral function, the optimization of Monte Carlo simulations, and how to incorporate covariance in the statistical errors of the Monte Carlo method.

31906 Thermodynamic behavior of a Penrose-tiling quasicrystal. Strandburg, K.J. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Dressel, P.R. *Physical Review, B: Condensed Matter (USA),* 41(4): 2469-2478 (1 Feb 1990).

The Penrose tiling provides a prototype for the quasiperiodic crystal model of quasicrystals. We report results of Monte Carlo simulations of a two-dimensional model in which a Penrose tiling is the ground state. A single energy is assigned to any violation of the Penrose matching rules. Our results support the existence of two separate phase transitions, corresponding to single- and double-arrow matching-rule disorder, respectively. Manifestations of these transitions in the behavior of "perpendicular-space" quantities are explored. A limited exploration of the effects of unequal double- and single-arrow matching-rule-violation energies is performed. Speculations that the Penrose pattern might be inherently prone to glassy behavior are shown to be incorrect.

31907 Spectral function of the Anderson model: A quantum Monte Carlo calculation. Biham, O. (Department of Physics, The Ohio State University, Columbus, Ohio 43210 (US)); Jarrell, M.; Jayaprakash, C. *Physical Review, B: Condensed Matter (USA),* 41(4): 2639-2642 (1 Feb 1990).

We have obtained the spectral function of the asymmetric Anderson model at low temperature through analytic continuation of quantum Monte Carlo data. While not quantitatively exact, the qualitative features of the spectral function clearly allow us to distinguish between the local-moment, mixed-valent, and empty-orbital regimes. We show how the spectral function changes as a function of particle-hole asymmetry and the Coulomb potential *U*.

6561 Superconductivity

Refer also to citation(s) 30737, 30745, 30748, 30749, 30751, 30753, 30754, 30760, 30762, 30764, 30779, 30802, 30803, 30804, 30805, 30806, 30808, 30809, 30810, 30812, 30815, 30819, 30820, 30823, 30824, 30826, 30829, 30830, 30831, 30843, 31004, 31010, 31011, 31012, 31013, 31014

31908 (CONF-900424–1) **$YBa_2Cu_3O_{7-x}$ thin film growth on single crystal and polycrystalline yttria-stabilized zirconia.** Norton, D.P. (Oak Ridge National Lab., TN (USA)); Lowndes, D.H.; Christen, D.K.; Budai, J.D.; Jones, E.C.; Ketcham, T.D.; St. Julien, D.; Lay, K.W.; Tkaczyk, J.E. Oak Ridge National Lab., TN (USA). Apr 1990. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Conference on the science and technology of thin film superconductors; Denver, CO (USA); 30 Apr - 4 may 1990. Order Number DE90010707. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper, we report on the growth of Y-123 thin films on single crystal and randomly-oriented polycrystalline YSZ substrates. High quality epitaxial Y-123 thin films were grown on (100) YSZ in order to identify the factors that determine the optimum growth conditions for this substrate material. In addition, we have grown Y-123 thin films that are highly c-axis oriented with a zero resistance T_{co} between 85 K and 89 K on both rigid and flexible randomly-oriented polycrystalline YSZ. Critical current densities in excess of 10^4 A/cm^2 at 77 K in zero magnetic field were obtained for the films on rigid polycrystalline substrates. According to recent work, this value for J_c approaches what appears to be the upper limit for J_c when large-angle grain boundaries are present in the film. 15 refs., 6 figs.

31909 (FNAL/C–90/72-T) **Chern-Simons and anyonic superconductivity.** Lykken, J.D. Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-9003152–1: Strings '90: superstring workshop, College Station, TX (USA), 12-17 Mar 1990). Order Number DE90010663. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Anyons are particles with fractional statistics. They can exist as point particles in a 2+1 dimension, or as quasiparticles in quasiplanar condensed matter systems in the real world. Anyonic particles can be modeled by ordinary bosons or fermions coupled to a "statistical" Chern-Simons abelian gauge field. For certain values of the statistics phase, a plasma of anyons in the Chern-Simons description is a superconductor. Anyonic superconductivity may represent an idealized limit of a new type of superconductor in real systems, perhaps encompassing the recently discovered high $T_c$copper oxides. 42 refs.

31910 (LA-UR–90-1402) **Changes in Fe site occupancy and T_c in $YBa_2(Cu_{1-x}Fe_x)_3O_y$ through processing.** Oesterreicher, H. (California Univ., San Diego, CA (USA)); Smith, M.G.; Taylor, R.D. Los Alamos National Lab., NM (USA). 6 Apr 1990. 10p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900527–2: ICMC '90 topical symposium on high temperature superconductors: materials aspects, Garmisch-Partenkirchen (Germany, F.R.), 9-11 May 1990). Order Number DE90010614. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Fe substitution for Cu in $YBa_2Cu_3O_y$ can give information about the local environment on the two crystallographic Cu sites through Mossbauer effect measurements. In this paper, we explore the possibility of forcing larger amounts of Fe onto the Cu (2) site which represents the CuO planes. At values near y = 6, the chain Cu (1) site is characteristic for Cu^+ in its linear 0 coordination and should preclude Fe occupation. We therefore prepared materials at elevated temperatures under N_2 where y ~6. Oxygenation to y ~7 was achieved at temperatures where metal diffusion is minimized.

We used Mossbauer spectroscopy to determine the Fe site occupancy. Site preference can be expressed in terms of a distribution ratio r = MCul/MCu2. Creating materials with low r allows studying the effects of spatially constrained Fe on T_c, separating influences from the spatially more complex Cu (1) site.

31911 Cooper pairs and composite bosons in two dimensions. Randeria, M. (Dept. of Physics and Materials Research Lab., Univ. of Illinois at Urbana-Champaign, Urbana, IL (US)); Duan, J.-M.; Shieh, L.-Y. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) ([1990]). Grants DMR86-12860;OMR 83-15550. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors review their recent work on the ground state of a 2D Fermi gas with given attractive interactions. They discuss the connection between pairing instability and binding in vacuum, the evolution of the ground state from cooperative BCS pairing to a condensate of composite bosons, and the distinction between the gap and the order parameter in the strong coupling regime. The relevance to the high T_c superconductors is discussed.

31912 Criterion for the superfluid/superconducting phase transition in two dimensions. Peters, D.S. (Lawrence Livermore Lab., Livermore, CA (US)); Alder, B.J. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports that He^4 films undergo a superfluid transition when the degeneracy parameter $(gl)^*/a \simeq 1$. This criterion also holds for the high temperature superconductors and, numerically, for Bose-Coulomb systems in two dimensions.

31913 Comparison of the electronic structure of La_2CuO_4, La_2NiO_4, and K_2CuF_4. Grant, J.B. (Lawrence Livermore National Lab., Univ. of California, Livermore, CA (US)); McMahan, A.K. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report local density calculations of parameters defining extended Hubbard Hamiltonians for La_2CUO_4, La_2NiO_4, and K_2CuF_4, and solve these models for small clusters. These results suggest qualitative differences among the three compounds in regard to spin system, carriers, and carrier - spin interactions.

31914 Structure of an isolated vortex in an anisotropic type-II superconductor. Klemm, R.A. (Ames Laboratory, Iowa State University, Ames, Iowa 50011 (USA)). *Physical Review, B: Condensed Matter (USA),* 41(1): 117-130 (1 Jan 1990). DOE Contract W-7405-ENG-82.

The Ginzburg-Landau equations with general effective-mass anisotropy are diagonalized for a general direction **v** of an isolated vortex core. For **v** not parallel to one of the three crystal axis directions, the local magnetic induction **b** contains components b_ρ and b_ϕ, perpendicular to **v**, which vanish as ρ^2 away from the center of the core with coefficients that are odd in the azimuthal angle ϕ. In the London limit far from the core, b_ρ and b_ϕ are comparable to $b_3=\hat{v}\cdot\mathbf{b}$, and all fall off exponentially in ρ, with two distinct exponents, each of which depends explicitly upon the azimuthal angle ϕ about $\hat{v}$. The presence of b_ρ and b_ϕ reduces the energy cost of the locking of the core into the lattice but does not remove it entirely, as the leading correction to the line energy is proportional to the parameter β^2 (rather than β), where β is the parameter introduced previously by the author. With the use of an ansatz, an exact form for the field components and reduced order parameter f in the core region is obtained. The lines of constant b_3 and $|b_\perp|$ in the core region are found for arbitrary effective-mass anisotropy and $\hat{v}$. These forms should be observable by scanning tunneling microscopy and by large-momentum-transfer neutron-scattering experiments for fields slightly greater than H_{c1}. In addition, the angular dependence of H_{c1} should exhibit a kink, as the vortex cores prefer to lie along one of the crystal symmetry directions.

31915 On anyon superconductivity–. Chen, Y.-H. (Institute for Advanced Study, Princeton, NJ (USA)); Wilczek, F.; Witten, E.; Halperin, B.I. *International Journal of Modern Physics B (USA),* 3(7): 1001-1068 (Jul 1989). Grant 86-20266.

We investigate the statistical mechanics of a gas of fractional statistics particles in 2 + 1 dimensions. In the case of statistics very close to Fermi statistics (statistical parameter $\theta = \pi(1 - 1/n)$, for large n), the effect of the statistics is a weak attraction. Building upon earlier RPA calculation for the case n = 2, the authors argue that for large n perturbation theory is reliable and exhibits superfluidity (or superconductivity after coupling to electromagnetism). They describe the order parameter for this superconductng phase in terms of spontaneous breaking of commutativity of translations as opposed to the usual pairing order parameters. The vortices of the superconducting anyon gas are charged, and superconducting order parameters of the usual type vanish. They investigate the characteristic P and T violating phenomenology.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 31678, 31805, 31807, 32027

31916 (CONF-8904308–2) **Limit behaviors of approximate solutions to conservation laws.** Chen, Gui-Qiang. New York Univ., NY (USA). Courant Inst. of Mathematical Sciences. [1989]. 27p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. GRANT DMS-850403. From Workshop on multi-dimensional hyperbolic problems and computations; Minneapolis, MN (USA); 3-14 Apr 1989. Order Number DE90010069. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are concerned with limit behaviors of approximate solutions to hyperbolic systems of conservation laws. Several mathematical compactness theories and their roles in this direction are described. Some recent and ongoing developments in this direction are reviewed and analyzed. 69 refs.

31917 (DOE/ER/25019–15) **Sustained resonance in very slowly varying oscillatory Hamiltonian systems.** Bosley, D.L.; Kevorkian, J. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. Mar 1990. 56p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-86ER25019. Order Number DE90010422. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

By formulating slowly varying oscillatory systems into Hamiltonian standard form, canonical averaging techniques can be performed automatically by symbolic manipulation programs to very high orders. For the very slow variation considered, these high orders are required to find uniformly valid solutions. When resonance is exhibited in these systems, the original system of 2N first order differential equations is reduced to two differential equations which embody the resonance behavior. Sustained resonance, also referred to as phase locking, occurs when the leading order frequency of the reduced system oscillates about zero for long times. The general solution procedure is illustrated, and a highly accurate asymptotic solution if found explicitly for a frequently occurring class of problems, which results when only a single harmonic of the resonance is present. This solution was not possible for the same class of problems with the usual slow time. Two test cases are considered to numerically verify all results. 24 refs., 13 figs.

31918 (INP–1344/PS, pp. 346-349) **Semimicroscopic calculation of ion-ion potentials.** Blin, A.H.; Brack, M.; Hiller, B.; Werner, E. Institute of Nuclear Research, Warsaw (Poland). 1986. (CONF-8604259–: 21. winter school of physics, Zakopane (Poland), 7-11 Apr 1986). In *Proceedings of 21. winter school on*

physics, Zakopane, Poland, 7-13 April, 1986: Part 1. Selected topics in nuclear structure. Order Number DE90625708. Available from NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS.

We derive the imaginary part of the ion-ion potential. We use Feshbach's projection formalism to write an equation for the wave function that describes the relative distance between the centres of mass of the two ions. We assume that the Q-space can be truncated at the excitation of 1p-1h states in either one or the other ion, leaving one of them in its ground state. The projected Schroedinger equation in the chosen subspace contains an effective potential V_{eff} which is truncated at second order of the elementary two-body interactions V. The matrix elements of the elementary interaction are of finite range, represented by an effective Wigner force. The total many-body wave function of the two ions is antisymmetrized only in the partial intrinsic wave function of each ion. This antisymmetrization is not treated explicitly, but contained in the effective interaction. Calculations are done in the Thomas-Fermi approximation. 5 refs., 1 fig. (author).

31919 (SAND–89-2951) **ANEOS analytic equations of state for shock physics codes input manual.** Thompson, S.L. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 69p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010198. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

ANEOS is an in-line software package which provides thermodynamic information for shock physics codes. Solids, liquids, vapors, plasmas and phase mixtures are considered in a thermodynamically consistent and complete manner. The package is flexible and easy to use. This users manual contains input instructions, examples, and descriptions of user output. 14 refs.

31920 (UCRL-ID–103335) **Prediction of high-voltage, broadband rf pulse generation from an air gas avalanche switch.** Mayhall, D.J.; Yee, J.H. Lawrence Livermore National Lab., CA (USA). Mar 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010183. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The generation of high-voltage, broadband rf pulses will make possible very important advances in radar technology. Recent two-dimensional computer code calculations on a simple air gas avalanche switch geometry predict the generation of unipolar electromagnetic pulses at voltages form 227 kV to 3.90 MV and bandwidths of about 24 GHz. Computational pulse tail chopping increases the bandwidths to 31 to 44 GHz. The gas avalanche switch consists of a set of pulse-charge is initiated between the electrodes by multiphoton ionization from a picosecond-scale laser pulse. The laser initiated electrons avalanche toward the anode and cause applied voltage to collapse in picoseconds, long before the hot current channel formation in a conventional sparkgap. This report investigates the behavior of gas avalanche switches, we have developed a two-dimensional code, GAS2D, which simultaneously and selfconsistently solves Maxwell's curl equations for transverse magnetic (TM) field modes in a gas between two parallel conductors along with a set of electron fluid conservation equations. A rectilinear perfect conductor may be placed between the parallel plates in the gas switching medium. 17 refs., 12 figs.

31921 (UCRL-ID–103346) **HUGOFIT and HUGOPLOT: Computer codes for plane shock wave analysis with materials that have non-simple Hugoniots.** Gathers, G.R. Lawrence Livermore National Lab., CA (USA). 25 Jan 1990. 61p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010284. Available from NTIS, PC A04/MF A01 - OSTI.

These two codes were written to accomodate plane shock wave data analysis and prediction for materials which are not adequately described by a simple linear u_s-u_p Hugoniot fit. As an example, kapton is a common flyer used in electric guns and falls into the above class of materials. The best tabulated data for its Hugoniot known to the author is that of Marsh (polyimide). The best fit can be obtained using a series of linear segments in the u_s-u_p plane. This is characteristic of materials that undergo phase changes on the Hugoniot. A substantial database for the EOS (equation of state) of many materials also exists at LLNL. The HUGOFIT code was written so that Hugoniots from that database (after conversion of units) could be readily fitted. The EOP library results are available on the mainframe computers at LLNL and the availability of graphics on these machines (and absence of graphics on the author's PC) made it simplest to write the codes for use on the mainframes. An added advantage is the ability to put out hardcopy to either fiche or RJET. The codes are written for the CRAY-1, but there is no intrinsic reason the codes cannot be adapted to a PC, and this is currently being done. One can also readily use tables of experimental data. The data to be fitted is entered from a file on disk called DATA. All other input is made from the teletype. The units for velocity were chosen to be km/sec since that is what the EOP library users. Densities are in g/cm^3 and pressures are in megabars.

31922 (UCRL-JC–103562) **New results from Nevada: A test of Newton's law using the BREN [Bare Reactor Experiment Nevada] tower and a high density ground gravity survey.** Kammeraad, J.; Kasameyer, P.; Fackler, O.; Felske, D.; Harris, R.; Millett, M.; Mugge, M.; Thomas, J. Lawrence Livermore National Lab., CA (USA). Apr 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900183–4: Recontres De Moriond '90: new and exotic phenomena, Les Arcs (France), 20-27 Jan 1990). Order Number DE90010690. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report new results from the LLNL test of Newton's law of gravity being conducted at the Nevada Test Site with a stable 465-m tower and a denser ground gravity survey than any used to date (823 locations within 4 km of the tower). Measurements of gravity at 12 heights on the tower were compared to predictions obtained with our surface gravity data and 60,000 measurements within 300 km provided by the USGS and NOAA. The predictions of gravity on the tower platforms were obtained using two different methods, which gave similar results. The results are consistent with Newton's law; we obtain chi-square = 4.9 with eleven degrees of freedom. We set constraints on the parameters of a hypothesized single Yukawa potential and properly included correlated uncertainties in this analysis. We show that if correlated errors are not included, the resulting constraints on the potential parameters are incorrect and appear to be stronger than in the correct analysis. 10 refs., 3 figs.

31923 **Anharmonic Grassmann oscillator. II.** Delbourgo, R. (Physics Department, University of Tasmania, Hobart, Australia 7005 (AU)); Jones, L.M.; White, M. *Physical Review, D (Particles Fields) (USA),* 41(2): 679-681 (15 Jan 1990). DOE Contract AC02-76ER01195.

A properly Hermitian anharmonic Grassmannian oscillator involves higher powers of quadratics in coordinates x and momenta p, as well as the scaling operator $x \cdot p$, and the Hamiltonian looks very different from the conventional bosonic case. Because these fermionic multinomials act on a finite space, it is possible to solve such problems completely. We do so for a number of typical examples.

31924 **Remarks on the Born-Oppenheimer approximation.** Wudka, J. (Physics Department, University of California at Davis, Davis, California 95616 (US)). *Physical Review, D (Particles Fields) (USA),* 41(2): 712-714 (15 Jan 1990).

The Born-Oppenheimer formulas, as modified by the introduction of the adiabatic connection, are derived from the effective action obtained by integrating out the fast variables. The parallels and differences with Berry's approach are stressed, and the corrections to the approximation are investigated.

31925 **Transfer-matrix analysis for Ising models.** Fuchs, N.H. (Department of Physics, Purdue University, West Lafayette, Indiana 47907 (US)). *Physical Review, B: Condensed Matter (USA),* 41(4): 2173-2183 (1 Feb 1990). DOE Contract FC05-85ER25000.

Some recently developed methods of numerical analysis are used to improve the standard transfer-matrix analysis of Ising spin systems. The method is used to analyze some properties of the two-dimensional anisotropic next-nearest-neighbor interaction model. Discrepancies in some recent work with respect to the existence and position of a disorder line are resolved, and some new properties of the phase diagram are demonstrated. It is argued that the modified transfer-matrix method is capable of being more generally applied.

70 FUSION ENERGY

Refer also to citation(s) 31877

31926 (AD-A-217605/5/XAB) **Distributed bosonic states and condensed-matter fusion. Final report, April-September 1989.** Chubb, S.R.; Chubb, T.A. Naval Research Lab., Washington, DC (USA). 1 Feb 1990. 19p. (NRL-MR-6600). Available from NTIS, PC A03/MF A01.

The article explains how it is possible for deuterons separated by macroscopic distances to interact in a nuclear fashion through the formation of a Bose Bloch Condensate (BBC) within a solid. Under suitable conditions, the formation of a BBC may lead to nuclear fusion and a variety of heretofore unobserved nuclear processes. The application of these ideas is used to explain the anomalous heating of Pd through the electrolysis of D_2O and LiOD and conclude that only a small concentration of BBC deutrons is required. Various experiments associated with condensed matter fusion are suggested that may provide a test of our theory.

7001 Plasma Research

Refer also to citation(s) 30181, 31103, 31975, 31980, 31981, 31992

31927 (ANL/FPP/TM-247) **Neoclassical effects on rf current drive.** Ehst, D.A. (Argonne National Lab., IL (USA). Fusion Power Program); Karney, C.F.F. Argonne National Lab., IL (USA). Fusion Power Program. Apr 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90010302. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A functional form is derived for the efficiency of current drive in toroidal geometry with low frequency waves (frequencies below the electron cyclotron frequency). By fitting constants in order to duplicate numerical results for the efficiency we obtain an accurate function which will be useful for computer calculations of current drive. 13 refs., 6 figs.

31928 (CNIC-00164) **Investigation of density scaling law and measurement of ion energy spectrum.** Tian Zhongyu (Southwest Inst. of Physics, Leshan, SC (China)); Ming Linzhou; Feng Xiaozhen. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 5p. (In Chinese). (SIP-0023). Order Number DE90625429. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The result that the plasma density is proportional to magnetic field square in our electrostatic plugging cusp device is presented. The density scaling law has been demonstrated correct. The measured typical average density is 5.6×19^{17} m^{-3} and confinement time is $3 \approx 5$ ms. The electronand ion energy spectra have been measured by means of multigrid analizer and double ion temperatures have been found. Typical results are 80eV and 140eV. The potential sag in anode region is about -184V. These results are discussed and analysised in detail.

31929 (CNIC-00177) **Experimental observation of hot electron ring on MM-2 mirror device.** Gu Biao (Southwest Inst. of Physics, Leshan, SC (China)); Guan Weishu; Cheng Shiqing; Chen Dingguo; Duan Shuyun; Su Tianhua; Shang Zhenkui. China Nuclear Information Centre, Beijing, BJ (China). Mar 1988. 9p. (In Chinese). (SIP-0025). Order Number DE90625444. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

A hot electron ring of $4 \approx 5$ cm radius was established on MM-2 simple mirror through ECRH of 15 kW, 15GHz microwave injection. The suppression of hot electron ring on low frequency fluctuations in plasma has been observed experimentally. It can be inferred from the burst, moment of those fluctuations that the ring can exist about $10 \approx 15$ ms after cutting off the microwave injection, even the X-ray radiation from hot electron can insist for $50 \approx 70$ ms. The preionization of H_2 will expend the beginning 2 ms of microwave pluse. The optimum background hydrogen pressure is 1.2×10^{-3} Pa to establish the hot electron ring if 15 kW microwave is injected for 9 ms.

31930 (CNIC-00180) **The plasma diagnostic of ECRH on MM-2.** Chen Dingguo (Southwest Inst. of Physics, Leshan, SC (China)); Su Tianhua; Guan Weishu; Cheng Shiqing. China Nuclear Information Centre, Beijing, BJ (China). Feb 1988. 9p. (In Chinese). (SIP-0026). Order Number DE90625515. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The diagnostic methods, experiment results and some discussin in MM-2 ECRH experiment for heating plasma and building a hot electron ring have been presented in this paper. By use of multigrid energy analyzer we measured the parameters: T_{ec}, n_{ec}, T_{ic}, n_{ic} and the profile of electron density in radial and the endloss. The method to measure the low-frequency fluctuation has been described briefly. From this measurement, the formtime and life time of the electron ring can be detected.

31931 (CNIC-00255) **Measurement of ion energy spectra in MM-4 fusion device.** Ming Lingzhou (Southwest Inst. of Physics, Leshan, SC (China)); Tian Zhongyu; Feng Xiaozhen; Feng Chuntang; Yin Yiujun; Liu Yihua. China Nuclear Information Centre, Beijing, BJ (China). Nov 1988. 6p. (In Chinese). (SIP-0028). Order Number DE90625430. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The ion temperature and plasma potential were measured by multi-grid energy analyzer in an electrostatic plugging cusp system MM-4. The results show that the plasma potential is -178 eV, and there are two ion temperatures in the plasma, typical values are 80 eV and 140 eV respectively. The obtained result is slightly different from others. The possible functions formed two ion temperatures are discussed.

31932 (CNIC-00256) **The measurement of potential distribution of plasma in MM-4 fusion device.** Tian Zhongyu (Southwest Inst. of Physics, Leshan, SC (China)); Ming Linzhou; Feng Xiaozhen; Feng Chuntang; Yi Youjun; Wang Jihai; Liu Yihua. China Nuclear Information Centre, Beijing, BJ (China). Nov 1988. 9p. (In Chinese). (SIP-0029). Order Number DE90625431. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Some experimental results of the potential distribution in MM-4 fusion device are presented by measuring the floating potential of probe. The results showed that the distribution of axial potential is asymmetrical, but the radial potential is symmetrical. There are double ion potential wells in the plasma. The depth of the deepest potential well become deeper is the strength of the magnetic field and injection current are increasing. The location of the deepest well is moved towards the device center along with the increasing of injection energy. This is different from others results. The mechanism of causing this distribution in also discussed.

31933 (CONF-900602-8) **Measurements of the fast ion distribution during neutral beam injection and ion cyclotron heating in ATF [Advanced Toroidal Facility].** Wade, M.R. (Georgia Inst. of Tech., Atlanta, GA (USA)); Kwon, M.; Thomas, C.E.; Colchin, R.J.; England, A.C.; Gossett, J.M.; Horton, L.D.; Isler, R.C.; Lyon, J.F.; Rasmussen, D.A. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90010150. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A neutral particle analyzer (NPA) with horizontal and vertical scanning capability has been used to make initial measurements of the fast ion distribution during neutral beam injection (NBI) and ion cyclotron heating (ICH) on the Advanced Toroidal Facility (ATF). These measurements are presented and compared with the results of modeling codes that predict the analyzer signals during these heating processes. 6 refs., 5 figs.

31934 (CONF-8908178-2) **A free boundary problem arising in plasma physics.** Kaper, H.G.; Kwong, Man Kam. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Gregynog international conference on nonlinear diffusion equations and their equilibrium states; Newton (UK); 20-29 Aug 1989. Order Number DE90010065. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This article is concerned with free boundary problems for the differential equation $u'' + (1/x)u' + f(u) = 0$, $x > 0$. In particular, it addresses the questions of existence and uniqueness of a finite

point P and a solution u satisfying the conditions $u'(0) = 0$; $u(x) > 0$, $0 < x < P$; $u(P) = u'(P) = 0$. Among the admissible nonlinearities are functions of the type $f(u) = u^p - u^q$ for certain combinations (p, q), where $0 \leq q < p \leq 1$, including the special case $f(u) = \sqrt{u} - 1$, which has been proposed in plasma physics as a simple model for Tokamak equilibria with magnetic islands. 7 refs.

31935 (CTH-IEFT-PP–1989-06) **Effects of parallel compressibility on ion temperature gradient driven modes.** Nordman, H.; Singh, R.; Weiland, J. Chalmers Univ. of Tech., Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics. 1989. 17p. Order Number DE90625532. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The effect of parallel ion motion in the stability of toroidal ion temperature gradient driven drift waves is presented. Analytic expressions for the eigenfrequency are obtained both in the strong ballooning limit and in a local limit including ion Landau damping. The parallel ion motion is found to be weakly stabilizing.

31936 (CTH-IEFT-PP–1989-07) **Low dimensional model of ion temperature gradient driven turbulence.** Nordman, H. Chalmers Univ. of Tech., Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics. 1989. 13p. Order Number DE90625533. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A complex Lorenz system is derived for toroidal ion temperature gradient driven drift wave turbulence. For tokamak relevant parameter values, the system evolves towards a nonlinear equilibrium where analytical expressions for the saturation levels and for the ion diffusion coefficient are obtained. The low-dimensional system is found to reproduce many essential properties of the full set as known from nonlinear numerical simulations.

31937 (CTH-IEFT-PP–1989-10) **On the stabilization of toroidal pinches by finite larmor radius effects and toroidal magnetic field.** Singh, R.; Weiland, J. Chalmers Univ. of Tech., Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics. 1989. 35p. Order Number DE90625534. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The radial eigenvalue problem for internal modes in a large aspect ratio toriodal pinch has been solved. A particularly stable regime for a weak but nonzero toroidal magnetic field has been found. (31 refs.).

31938 (DOE/ET/53088–6) **Institute for Fusion Studies progress report, November 1, 1989–October 31, 1990.** Baldwin, D.E. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Apr 1990. 66p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. Order Number DE90010789. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

During the past year significant progress was made in carrying out theoretical investigations pursuant to the scientific mission of the Institute. These achievements may be approximately classified in terms of the following research categories (often with considerable overlap); tokamak MHD studies, turbulence theory and plasma transport, computational plasma physics, stability theory, mathematical physics, advanced ideas, and space plasma physics-related problems. An overview of this work is contained in this report. This paper contains a list of the numerous scientific papers published in technical journals by IFS scientists during the past year. Also, detailed summaries of IFS Reports written during FY 90 are given in abstract form in Appendix A of this report. It is worth noting that, in addition to the many research publications, two lengthy review articles were written during the past year at the IFS: one on nonlinear drift waves and transport in magnetized plasmas, and the other an introduction to bifurcation theory.

31939 (GA-A–20077) **Scaling dimensionally similar tokamak discharges to ignition.** Waltz, R.E.; DeBoo, J.C.; Rosenbluth, M.N. General Atomics, San Diego, CA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114. (CONF-900602–7: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90010079. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The tokamak operates in a variety of confinement regimes suggesting there may be several transport mechanisms in combination. The detailed parametric dependence of each is likely to be very complicated. However, it can be argued that all plasma diffusion mechanisms can be divided into the extremes of gyro-Bohm (gB) or Bohm (B) types depending on their scaling with ion gyroradius ρ_s relative to the minor radius a: $\rho_s a$. These correspond to turbulent diffusion processes with short or long step sizes scaled to ρ_s or a, respectively. The local diffusivities and confinement times can be written as $D_{gB} = (c_s/a)\rho_s{}^2 F_{gB}$ or $D_B = c_s \rho_s F_B$ and $\tau_{gB} = B^{-1}(\rho_s/a)^{-3}\tilde{F}_{gB}$ or $\tau_B = B^{-1}(\rho_s/a)^{-2}\tilde{F}_B$, respectively. The form factors are possibly complicated functions of the dimensionless parameters associated with geometry, atomic and profile parameters, and the plasma parameters collisionality ($\tilde{\nu} \propto \nu a/c_s$) and β. Discharges with all these dimensionless parameters including ρ_s/a the same would have $\tau \propto B^{-1}$ and could be called dimensionally identical in their transport properties. It is well known that isolating the dependence on the dimensionless variables imposes a single constraint on the scaling of τ with respect to machine variables. In this paper, we observe that while dimensionally identical discharges cannot be scaled to ignition, existing and proposed ignition regime tokamak discharges can have all these dimensionless parameters the same except ρ_s/a. We shall call such discharges "dimensionally similar" and focus on the scalings with respect to ρ_s/a.

31940 (GSI–85-21) **Studies on the feasibility of heavy ion beams for inertial confinement fusion. Annual report 1984.** Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Aug 1985. 76p. Order Number DE90784837. Available from NTIS (US Sales Only), PC A05/MF A01.

This Annual Report summarizes experimental and theoretical investigations carried out in the framework of a feasibility study of inertial confinement fusion by heavy ion beams, funded by the Federal Ministry for Research and Technology. After the completion of the conceptual design study HIBALL with an upgraded version, the investigations concentrated in 1984 mainly on problems of accelerator and target physics. In the area of accelerator physics the main interest was in the production and acceleration of high intensity heavy ion beams of high phase space density and in beam dynamics theory, in the area of target physics on beam-target interaction, radiation hydrodynamics, instabilities and the equation of state of highly compressed hot matter. (orig./AH).

31941 (IPF–88-3) **Analytical theory of the Bunemann instability for electron runaway.** Kaeppeler, H.J. Stuttgart Univ. (Germany, F.R.). Inst. fuer Plasmaforschung. Oct 1988. 13p. Order Number DE90784789. Available from NTIS (US Sales Only), PC A03/MF A01.

Generally, analytical expressions for the growth rate of the Bunemann instability are given for small ratios of beam density n_b to plasma density n_p and are derived for zero applied electric field. In the case of this instability caused by runaway electrons, e.g. in the dense plasma focus or z-pinch, there exists an appreciable induced electric field strength and the assumption of $n_b/n_p << 1$ can no longer be made. In this report, a simplified dispersion relation including an applied, time-variable electric field is derived and an approximate analytical expression for the temporal growth rate is given. The magnetic field is assumed to be zero. (orig.).

31942 (IPP–1/249) **On the possibility of measuring the q-profile in dense plasmas by means of molecular beams.** Herrmann, W. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Sep 1989. 30p. Order Number DE90784791. Available from NTIS (US Sales Only), PC A03/MF A01.

A method of measuring the q-profile (slightly off the centre) in a plasma is described in detail. Radially injected molecular neutrals are ionized in the plasma and rotate according to the local magnetic field. After dissociation the neutral atom carries the information on the velocity of the molecular ion at the time of dissociation to a neutral particle analyzer. In this paper it is shown how this information can be used to calculate the local field. The production and penetration of molecular beams are discussed as well as the requirements to be met by the beam and analyzer. Also discussed are the possibility and influence of neutral atom beams and their possible relevance to the same type of measurement. It

is shown that the Shafranov shift can be determined by suitable choices of the injection and detection geometries. The method seems to be especially suited to measuring the time variation of local q-values with a time resolution of about 1 ms. Although the penetration of the particles depends on the plasma conditions, the quantity measured by the method discussed only depends on the local field ratio. It is shown that the method could also be applied in large plasma experiments the size of JET, and that an accuracy in measuring q of better than or about 10% may be achieved. (orig.).

31943 (IPP–2/303) **Monte Carlo evaluation of neoclassical transport in torsatrons with different helical winding laws.** Beidler, C.D. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Hitchon, W.N.G.; Grekov, D.L.; Shishkin, A.A. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Sep 1989. 21p. Order Number DE90784790. Available from NTIS (US Sales Only), PC A03/MF A01.

Neoclassical transport in realistic torsatron magnetic fields of reactor size is estimated by use of the Monte Carlo simulation technique. The configurations examined differ in the winding law which describes their helical conductors, a difference which has been analytically predicted to yield differing transport levels. This effect is confirmed not only in the $1/\nu$ regime, for which the analytic calculations were originally done, but at much lower collision frequencies as well. For the torsatrons examined, overall transport rates differ by a factor of 1.5-3. It is noted that the configuration with the more favorable transport characteristics bears some similarity to an Advanced Stellarator. (orig.).

31944 (IPPCZ–294) **Model of oxygen ions resonant lines emission of REB-heated plasma.** Raus, J.; Babicky, V. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Jun 1989. 26p. Order Number DE90623615. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The time dependent intensities of selected resonance lines of oxygen impurity in ionization stages O^{2+} - O^{5+} in a hydrogen plasma with an electron density about 10^{15} cm^{-3}, are calculated by using the nonstationary corona model with variable electron temperature of a maximum value of 20 - 50 eV (plasma parameters of the REBEX experiment), to judge the possibilities of measurements in preparation and to facilitate their interpretation. Simultaneously, the rough form of XRD signals corresponding to these parameters, and the influence of radiation losses on plasma decay are shown. (author). 24 figs., 2 tabs., 15 refs.

31945 (LA-UR–90-1366) **A Mirnov loop array for field-reversed configurations.** Tuszewski, M. Los Alamos National Lab., NM (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-900557–2: 8. topical conference on high-temperature plasma diagnostics, Hyannis, MA (USA), 6-10 May 1990). Order Number DE90010607. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An array of 64 magnetic pick-up loops has been used for stability studies of large field-reversed configurations in the FRX-C/LSM device. This array proved reliable, could resolve signals of a few Gauss, and allowed the detection of several plasma instabilities. 3 refs., 4 figs.

31946 (PPPL–2675) **Parallel electric resistivity in the TFTR tokamak.** Zarnstorff, M.C.; McGuire, K.; Bell, M.G.; Grek, B.; Johnson, D.; McCune, D.; Park, H.; Ramsey, A.; Taylor, G. Princeton Univ., NJ (USA). Plasma Physics Lab. May 1990. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90010170. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The average parallel resistivity and the location of the q = 1 surface are found to be consistent with the predictions of neoclassical transport theory and inconsistent with classical resistivity (uncorrected for toroidal effects) for ohmic plasmas in the TFTR tokamak, both in near-equilibrium and during ramping of the plasma current. These observations are incompatible with theories predicting anomalous parallel resistivity in concert with anomalous perpendicular transport. 41 refs., 9 figs., 1 tab.

31947 (PPPL–2682) **Novel target configurations for selective ionization state studies in molybdenum.** Ilcisin, K.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Feldman, U.; Schwob, J.L.; Wouters, A.; Suckewer, S. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008231. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Details of experiments aimed at achieving low ionization state selectivity in molybdenum are presented. Targets are excited with a 10 J CO_2 laser and the resultant VUV spectrum (300–700 Å) has been studied. Combinations of focal spot size, target depth, and target geometries are compared. Simple attenuation of energy is shown not to vary ionization stage composition significantly. Experiments conducted with grazing incidence targets result only in a hot plasma. Modular targets with cooling cylinders of various radii demonstrated good selectivity of the ionization states, but with low absolute signals. Finally, results from combinations of focal spot adjustment and radiative cooling illustrate increased control over desired plasma temperature and density for spectroscopic studies of molybdenum. 7 refs., 14 figs.

31948 (PPPL–2690) **Summary of TFTR [Tokamak Fusion Test Reactor] diagnostics, including JET [Joint European Torus] and JT-60.** Hill, K.W.; Young, K.M.; Johnson, L.C. Princeton Univ., NJ (USA). Plasma Physics Lab. May 1990. 42p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90010278. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The diagnostic instrumentation on TFTR (Tokamak Fusion Test Reactor) and the specific properties of each diagnostic, i.e., number of channels, time resolution, wavelength range, etc., are summarized in tables, grouped according to the plasma parameter measured. For comparison, the equivalent diagnostic capabilities of JET (Joint European Torus) and the Japanese large tokamak, JT-60, as of late 1987 are also listed in the tables. Extensive references are given to publications on each instrument.

31949 (PPPL–2692) **Propagations of drift waves in toroidal plasma systems.** Yoshikawa, S.; Cheng, C.Z. Princeton Univ., NJ (USA). Plasma Physics Lab. May 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90010279. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Drift wave patterns in toroidal plasmas are studied. The dispersion relation was simplified to retain both the shear and the toroidal coupling effects. Since the dispersion relation does not depend on the toroidal angle, ϕ, the dispersion is solved in the two- dimensional space made up with minor radius and poloidal angle. The dispersion relation can be reduced into second-order, partial differential equations of a hyperbolic type. The one-dimensional convective mode analysis, which was originated in the 1960's, was extended into the two-dimensional analysis. Depending on the strength of the magnetic shear, one can obtain either the convective or the localized solutions. The results show that the plasma is expected to be unstable for large azimuthal mode number and that the plasma instability tends to be more stabilized for large mass ions. 8 refs., 3 figs., 1 tab.

31950 (RAL–89-127) **MED101: a laser-plasma simulation code. User guide.** Rodgers, P.A. (Rutherford Appleton Lab., Chilton (UK)); Rose, S.J.; Rogoyski, A.M. Rutherford Appleton Lab., Chilton (UK). Dec 1989. 60p. Order Number DE90625525. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Complete details for running the 1-D laser-plasma simulation code MED101 are given including: an explanation of the input parameters, instructions for running on the Rutherford Appleton Laboratory IBM, Atlas Centre Cray X-MP and DEC VAX, and information on three new graphics packages. The code, based on the existing MEDUSA code, is capable of simulating a wide range of laser-produced plasma experiments including the calculation of X-ray laser gain. (author).

31951 (UCRL–102438) **Massively parallel Fokker-Planck calculations.** Mirin, A.A. Lawrence Livermore National Lab., CA (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9004159–5: 5. distributed memory computing conference, Charleston, SC (USA), 9-12 Apr

1990). Order Number DE90010691. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Fokker-Planck package FPPAC, which solves the complete nonlinear multispecies Fokker-Planck collision operator for a plasma in two-dimensional velocity space, has been rewritten for the Connection Machine 2. This has involved allocation of variables either to the front end or the CM2, minimization of data flow, and replacement of Cray-optimized algorithms with ones suitable for a massively parallel architecture. Coding has been done utilizing Connection Machine Fortran. Calculations have been carried out on various Connection Machines throughout the country. Results and timings on these machines have been compared to each other and to those on the static memory Cray-2 at the National Magnetic Fusion Energy Computer Center. For large problem size, the Connection Machine 2 is found to be cost-efficient. 6 refs., 7 tabs.

31952 (UCRL-ID–103429) **Computational physics at the National Energy Research Supercomputer Center.** Mirin, A.A. Lawrence Livermore National Lab., CA (USA). Apr 1990. 112p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE90010283. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The principal roles of the Computational Physics Group are (1) to develop efficient numerical algorithms, programming techniques and applications software for current and future generations of supercomputers, (2) to develop advanced numerical models for the investigation of plasma phenomena and the simulation of contemporary magnetic fusion devices, and (3) to serve as a liaison between the Center and the user community; in particular; to provide NERSC with an application-oriented viewpoint and to provide the user community with expertise on the effective usage of the computers. In addition, many of our computer codes employ state-of the-art algorithms that test the prototypical hardware and software features of the various computers. This document describes the activities of the Computational Physics Group and was prepared with the assistance of the various Group members. The fist part contains overviews on a number of our important projects. The second section lists our important computational models. The third part provides a comprehensive list of our publications.

31953 (UCRL-JC–102929) **Electron cyclotron current drive experiments on DIII-D.** James, R.A. (Lawrence Livermore National Lab., CA (USA)); Giruzzi, G.; Gentile, B. de; Rodriguez, L.; Fyaretdinov, A.; Gorelov, Yu.; Trukhin, V.; Harvey, R.; Lohr, J.; Luce, T.C. Lawrence Livermore National Lab., CA (USA). May 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48;AC03-89ER51114. (CONF-900602–9: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90010758. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Electron Cyclotron Current Drive (ECCD) experiments on the DIII-D tokamak have been performed using 60 GHz waves launched from the high field side of the torus. Preliminary analysis indicates rf driven currents between 50 and 100 kA in discharges with total plasma currents between 200 and 500 kA. These are the first ECCD experiments with strong first pass absorption, localized deposition of the rf power, and τ_E much longer than the slowing-down time of the rf generated current carriers. The experimentally measured profiles for T_e, η_e and Z_{eff} are used as input for a 1D transport code and a multiply-ray, 3D ray tracing code. Comparisons with theory and assessment of the influence of the residual electric field, using a Fokker-Planck code, are in progress. The ECH power levels were between 1 and 1.5 MW with pulse lengths of about 500 msec. ECCD experiments worldwide are motivated by issues relating to the physics and technical advantages of the use of high frequency rf waves to drive localized currents. ECCD is accomplished by preferentially heating electrons moving in one toroidal direction, reducing their collisionality and thereby producing a non-inductively driven toroidal current. 6 refs., 4 figs.

31954 Measurements of flux surfaces in the ATF torsatron. England, A.C. (Oak Ridge National Lab., TN (USA)); Colchin, R.J.; Harris, J.H.; Hillis, D.L.; Jernigan, T.C.; Anderson, F.S.B.; Hanson, J.D.; Henderson, M.A.; Gandy, R.F.; Lee, D.K. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Flux surfaces in the advanced toroidal facility (ATF) torsatron have been measured using electron-beam techniques. The beam was injected toroidally and impinged on a phosphor-coated screen located ~ 180° from the gun. The gun was mounted on a drive mechanism that enabled the beam to scan the entire cross section of the last closed flux surface in ATF. The screen material was st. steel, coated with ZnO:Zn (P-15 or P-24) phosphor, and the transparency was ~ 90%. The emitted light was detected with an image-intensified CCD camera that viewed the mesh through a nearby port. The images were displayed directly on a TV monitor and stored on video tape. Frames from the video tape were transferred to a computer, where the image was enhanced and transformed to remove spatial distortions due to the lens and the viewing angle of the camera.

31955 Ultrafast framing of x-ray images. Stearns, D.G. (Lawrence Livermore National Lab., CA (USA)); Wiedwald, J.D.; Cook, B.M.; Hanks, R.L.; Landen, O.L. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

In this paper the authors describe the development of a high resolution x-ray framing camera[2] (XFC) to be used to image the soft x-ray emission from laser-produced plasmas on a picosecond timescale. The XFC generates a single frame with 50 ps temporal resolution 22 um spatial resolutuion at the image plane and real time readout. The camera is optically triggered, resulting in jitter-free synchronization of the frame time with the laser experiment, making it possible to integrate multiple shots with no loss of temporal resolution. One of the first applications of the XFC will be to image the dynamic implosion of micro-balloon fuel pellets for laser fusion using the Nova 10-beam laser.

31956 Nature of convection-stabilized dc arcs in dual-flow nozzle geometry: Part I: The cold flow field and dc arc characteristics–. . Serbetci, I. (NASA-Lewis Research Center, Space Propulsion Division, MS 500-219, Cleveland, OH (US)); Nagamatsu, H.T. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 91-101 (Feb 1990).

In this paper, an experimental investigation of the steady-state low-current air arcs in a dual-flow nozzle system is presented. First, the cold flow with no arc as determined for various nozzle geometries, i.e., two- and three-dimensional and orifice nozzles, and nozzle pressure ratios. Supersonic flow separation and oblique and detached shock waves were observed in the flow field. Using a finite-element computer program, the Mach number contours were determined in the flow field for various nozzle-gap spacings and pressure ratios. In addition, the dc arc voltage and current measurements were made for an electrode gap spacing of ≈ 5.5 cm and current levels of I ≈ 25, 50, and 100 A for the three nozzle geometries. The arc voltage and arc power increased rapidly as the flow speed increased from zero to sonic velocity at the nozzle throat. The shock waves in the converging-diverging nozzles resulted in a decrease in the overall resistance by about 15 percent.

31957 Further studies of ELF oscillationss during electron-beam firings on Spacelab 1–. Marshall, J.A. (Southwest Research Institute, San Antonio, TX (US)); Lin, C.S.; Burch, J.L. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 169-170 (Feb 1990).

This paper reports injections from an electron beam that comprised part of the PICPAB (phenomena induced by charged particle beams) experiment observed by the SepAC (space experiments with particle accelerators) plasma diagnostic package. In particular, extremely low-frequency (ELF) oscillations from 150 to 200 Hz were seen in the SepAC Langmuir probe current. The strongest oscillations occurred when the ambient pressure was augmented by neutral gas releases from the SepAC plasma accelerator (the magnetoplasma dynamic arcjet, or MPD).

31958 Excitation of the lower-hybrid resonance at the plasma edge by ICRF couplers–. Berro, E.A. (Dept. of Physics, Univ. of California, Los Angeles, CA (US)); Morales, G.J. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 142-148 (Feb 1990).

A simple model is presented to examine the inadvertent excitation of the lower-hybrid resonance by fast wave couplers. Loading resistances due to this effect are found to be on the order of 0.1 Ω for present generation experiments and increase with the toroidal magnetic field. An upper-bound estimate of 1 keV is obtained for the energy transferred to edge ions by the resonance.

31959 Nature of convection-stabilized dc arcs in dual-flow nozzle geometry: Part II: optical diagnostics and theory–. . Serbetci, I. (Dept. of Mechanical Engineering, Aeronautical Engineering and Mechanics, Rensselaer Polytechnic Institute, Troy, NY (US)); Nagamatsu, H.T. *IEEE Transactions on Plasma Science (Institute of Electrical and Electronics Engineers) (USA),* 18(1): 102-114 (Feb 1990).

A supersonic flow field with a 5.5-cm and ≈ 2.2-mm thick cylindrical arc plasma column was observed with a four-mirror Schlieren optical system in dual-flow nozzle geometries. For both the orifice-type nozzle and the two-dimensional covergent-divergent nozzle, the arc current was varied from 45 to 110A. The optical cold flow-plasma boundary displayed a sharp and laminar character in both nozzles. A Wollaston prism interferometer was assembled to observe the density distribution in the arc for the two-dimensional nozzle. Similar to the Schlieren photographs, the Wollaston interferometer displays a sharply defined, almost constant diameter and quiet arc between the nozzles. Downstream of the nozzle throat the arc expands and assumes a conical shape. In this region, the fringe formation inside the arc is still clear, which is an indication of the laminar nature of the plasma. However, the arc boundary is not as distinct. Both of the optical techniques revealed a cooler arc downstream of the nozzle throat. Using the experimentally determined axial static pressure and coldflow mass flux rate distributions and the channel-flow model with constant arc temperature, the energy integral is solved for the arc radius as a function of the axial distance. From this, the arc electric field strength, voltage, resistance, and power has been determined through Ohm's law, and the total heat transfer is related to the arc power.

31960 Giant ion sources of neutral-beam injectors for fusion (invited). Kunkel, W.B. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)). *Review of Scientific Instruments (USA),* 61(1): 354-359 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

All large tokamak fusion experiments today use auxiliary heating by multimegawatt beams of neutral isotopes of hydrogen injected with energies in the neighborhood of 100 keV per atom. This requires reliable operation of large ion souces, each delivering many tens of amperes of protons or deuterons, and soon even tritons. For meaningful experiments these sources must operate with pulse durations measured in seconds, although the duty factor may still be small. It is remarkable that the successful sources developed in Europe, Japan, and the U. S. are all very similar in basic design: the plasma is produced by diffuse low-pressure high-current discharges in magnetic multipole "buckets" with distributed thermionically emitting cathodes. This article briefly reviews the principal considerations and the basic physics of these sources, and summarizes the collective experience to-date and describes the impressive recent performance of the U. S. Common Long Pulse Source, as a specific example.

31961 Observation of stimulated Compton scattering from resonant electrons in a laser-produced plasma. Drake, R.P. (Lawrence Livermore National Laboratory, Livermore, California 94550 (US)— National Research Council, Ottawa, Ontario, Canada K1A0R6— KMS Fusion, Inc., Ann Arbor, Michigan 48105— Institut National de la Recherche Scientifique-Energie, Varennes, *Physical Review Letters (USA),* 64(4): 423-426 (22 Jan 1990). DOE Contract W-7405-ENG-48.

An experimental study of stimulated Compton scattering (SCS) from resonant electrons in a laser-produced plasma is reported. Up to 1.9 kJ of 350-nm laser light was used to irradiate 3-μm-thick CH targets in 1.3 to 3.3-ns pulses at intensities up to 1.3×10^{15} W/cm^2. SCS was detected by making time-resolved measurements of the emission near 420 nm. The measurements are compared to the results of theoretical modeling.

31962 Local measurements of correlated momentum and heat transport in the TFTR tokamak. Scott, S.D.; Diamond, P.H.; Fonck, R.J.; Goldston, R.J.; Howell, R.B.; Jaehnig, K.P.; Schilling, G.; Synakowski, E.J.; Zarnstorff, M.C.; Bush, C.E. *Physical Review Letters (USA),* 64(5): 531-534 (29 Jan 1990). DOE Contract AC02-76CH03073.

Simultaneous profile measurements of the toroidal rotation speed and ion temperature during unbalanced neutral beam injection in the Tokamak Fusion Test Reactor show that the ion momentum and thermal diffusivities are comparable in magnitude ($\chi_\phi \approx 1.5\chi_I$) and vary similarly with plasma current and minor radius. The correlation of χ_ϕ and χ_I is consistent with anomalous transport driven by collisionless electrostatic microinstabilities including ion-temperature-gradient-driven modes (η_I modes) and collisionless trapped-electron modes.

31963 Ion sources for light-ion fusion (invited). Gerber, R.A. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)); Bieg, K.W.; Dreike, P.L.; McKay, P.F.; Pregenzer, A.L.; Tisone, G.C. *Review of Scientific Instruments (USA),* 61(1): 511-516 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Light-ion drivers offer a potentially efficient and low-cost method to compress and heat an inertial-confinement fusion (ICF) target. In order to produce a significant thermonuclear burn of the fuel, focused ion-beam intensities of 100 TW/cm^2 are required. The ion sources for these pulsed-power drivers should produce a single-ion species and should be capable of providing current-density levels up to 5 kA/cm^2, in pulse widths of 10–20 ns, at voltages up to several tens of megavolts. Most ion sources used in the past have produced multiple-ion species, including protons and heavier ions, such as carbon and oxygen. In the last few years there has been a substantial research effort to produce single-species sources. The major effort since 1983 has been directed towards developing a pure, high-current Li^+ source for the light-ion fusion accelerator, PBFA II. There are two types of ion sources being used for intense ion-beam generation: (1) passive sources which are produced directly or indirectly by the diode voltage itself; and (2) active sources, in which a preformed plasma is generated before the arrival of the power pulse. A survey of existing ion sources and those under development will be given. Emphasis will be given to the lithium-ion sources being developed at Sandia National Laboratories (SNL).

31964 Development of the BOLVAPS lithium vapor source for the PBFA-II accelerator. Dreike, P.L.; Appel, D.B.; Cap, J.S.; Gerstle, F.P.; Lamppa, K.P.; Mattox, D.M.; McCollister, H.L.; Moore, R.H.; Neilsen, M.K.; Peepies, C.R. *Review of Scientific Instruments (USA),* 61(1): 532-534 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A pulsed, large area, Li vapor source for use in the PBFA-II ion beam diode is described. BOLVAPS (boil-off lithium vapor source) produces a 1–2 mm thick layer of Li vapor with a density approaching 1×10^{17} cm^{-3} by rapid ohmic heating of a thin-film laminate, one layer of which contains Li. The principal design issues of the vapor source being built for use on the PBFA-II accelerator are described. Results of small-scale development experiments are summarized.

31965 Lithium fluoride ion source experiments on PBFA II. Bieg, K.W.; Pregenzer, A.L.; Woodworth, J.R.; Lockner, T.R.; Johnson, D.J.; Gerber, R.A.; Bailey, J.E.; Kensek, R.P.; Leeper, R.J.; Maenchen, J.E. *Review of Scientific Instruments (USA),* 61(1): 556-558 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Lithium fluoride, field-enhanced ion source experiments are being performed on PBFA II. The source consists of a thin coating of LiF on a microscopically rough substrate. Diagnostics to measure ion beam energy, purity, and transport include electrical monitors,

Faraday cups, nuclear activation, ion pinhole camera, Rutherford magnetic spectrograph, and shadowbox aperture array. With PBFA II operating at three-quarters energy, the source has produced 16 TW of ion power and 550 kJ of ion energy with 70% diode efficiency. Over 26 kJ of lithium beam energy has been focused to the diode center axis with a peak energy density of about 1.3 kJ/cm^2 . PICDIAG simulations of the lithium focus indicate the intrinsic source divergence is about 45 mrad with a 20-μm-grade porous stainless-steel substrate.

31966 **Ion production on the PI-110A accelerator.** McKay, P.F. (Sandia National Laboratories, Albuquerque, New Mexico, 87185 (US)); Bieg, K.W.; Olson, R.E.; Pregenzer, A.L.; Wiemann, D.K. *Review of Scientific Instruments (USA),* 61(1): 559-561 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Lithium ion and proton source experiments have been performed using an extraction geometry applied-B ion diode on the 0.02-TW PI-110A accelerator. These sources are being developed for use in inertial confinement fusion (ICF). The proton source relies on surface flashover to form an anode plasma from which the protons are drawn. The lithium sources seem to depend upon the local electric field for operation. The applied electric field was enhanced in the experiment by the geometry of the anode surface. For the proton source, ion generation was reduced when the applied magnetic field was increased. By contrast, lithium ion generation continued to increase as the applied magnetic field was increased. The effect of anode temperature was investigated for two lithium sources and was found not to be a factor in ion generation. Measurements of the turn-on characteristics of the various ion sources show shorter turn-on delays with higher diode voltage.

31967 **Generation of lithium ions for ion sources using the 670.8-nm resonant transition of lithium.** Tisone, G.C. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)); Bieg, K.W.; Dreike, P.L. *Review of Scientific Instruments (USA),* 61(1): 562-564 (Jan 1990). DOE Contract AC04-76DP00789. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

This article describes research on two methods of producing a 1-mm-thick singly ionized lithium plasma with an areal density up to 1×10^{16} cm^{-2}. The first method relies on forming a 1-mm-thick layer of lithium vapor by ohmically pulse heating a thin film of a lithium bearing compound. The vapor is then ionized by a 670.8-nm laser light, the first resonant transition of lithium. Small scale experiments described here demonstrated average electron densities up to 5×10^{16} cm^{-3}, using laser energy densities as low as 20 mJ/cm^2 . The second method is direct heating, evaporation, and ionization of thin lithium bearing films on thermally insulating substrates using 670.8-nm laser light. The minimum *tuned* laser energy density for producing a plasma was 0.15 J/cm^2 . These results are compared with measurements at other wavelengths and pulse lengths, and with models of the heating and ionization.

31968 **Magnetically insulated helium ion diode.** Wessel, F.J. (Physics Department, University of California, Irvine, California 92717 (US)); Heidbrink, W.W.; Drum, S.; Hoang, K.; Layton, P. *Review of Scientific Instruments (USA),* 61(1): 565-567 (Jan 1990). DOE Contract FG03-89ER53282. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A gas-puff magnetically insulated ion diode is under development as a pulsed source of high-energy alpha particles for magnetic fusion experiments. The diode is patterned after the Cornell gas-puff diode [J. B. Greenly, M. Ueda, G. D. Rondeau, and D. A. Hammer, J. Appl. Phys. **63**, 1872 (1988)], but with modifications to accomodate higher voltages (<1 MeV) and operation in helium. The diode is designed to yield current densities approaching 200 A/cm^2 one meter downstream from the source; in our first test of the new source, a helium beam was obtained.

31969 **Electrohydrodynamically driven, large-area liquid metal ion source for inertial confinement fusion.** Pregenzer, A.L. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)). *Review of Scientific Instruments (USA),* 61(1): 571-573 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

Analysis of the electrohydrodynamic (EHD) equations of motion of a planar liquid-lithium surface in the presence of a normal electric field suggest that liquid lithium may provide a large-area ion source for intense ion-beam diodes. Such sources are being developed for the Particle Beam Fusion Accelerator II at Sandia National Laboratories. In this paper, theoretical and experimental studies of the planar EHD ion source will be reviewed. When a planar liquid surface is subjected to an electric field of sufficient magnitude, EHD instabilities produce an array of cusps on the surface. The electric field enhancement at the apex of each cusp is sufficient to permit field evaporation of ions. The time delay between application of the electric field and ion emission depends on the magnitude and rate of increase of the applied electric field, and on the initial amplitude of the surface perturbation. Above 10 MV/cm, theory indicates that field emission will occur on a nanosecond time scale and that the characteristic spacing of emitters will be <1 μm. At these fields, the source should have an intrinsic divergence of <6 mrad and the effects of space charge from neighboring emitters should not inhibit emission significantly. Experimental measurements of wavelengths and cusp-formation-times for water and ethanol at electric fields near the critical field for instability have agreed well with theory.

31970 *In situ* **density and temperature measurements of vibrationally excited hydrogen molecules in ion source plasmas.** Stutzin, G.C. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)); Young, A.T.; Doebele, H.F.; Schlachter, A.S.; Leung, K.N.; Kunkel, W.B. *Review of Scientific Instruments (USA),* 61(1): 619-621 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

The role of highly vibrationally excited hydrogen molecules has been postulated to be of great importance in H^- ion sources. However the the difficulty of making *in situ* measurements has led to a paucity of direct determinations of these species within the plasmas of these sources. Recently, vacuum-ultraviolet (VUV) laser absorption spectroscopy has been used to measure the H_2 rovibrational populations up to v''=5 and J''=8 in a medium-power hydrogen plasma. This work extends those measurements to v''=8 and to J''=13. The populations of the vibrational levels still appear to be almost Boltzmann. The theoretically predicted plateau is not observed up to the detection limit. The dependence of several vibrational levels on discharge current and filling pressure is shown.

31971 **MHD model of explosive coalescence of magnetic islands.** Tajima, T. (Institute for Fusion Studies, The University of Texas at Austin, Austin, TX (US)— Department of Applied Mathematics and Physics, University of Toyama, Toyama, Japan (US)); Sakai, J.-I. *Soviet Journal of Plasma Physics (English Translation) (USA),* 15(9): 606-612 (Sep 1989).

An MHD simulation of the explosive coalescence of magnetic islands has been carried out. The results agree with the conclusions found through a particle simulation of this process. A theoretical model is proposed to interpret the observed phenomena. This theory describes magnetic collapse. It is based on self-similar solutions of the equations of two-fluid hydrodynamics, since the numerical simulation indicates that self-similar regimes prevail during certain time intervals. An equation which determines the time sale in the self-similar solutions is derived. It has the form of the equation of motion of a particle in an effective potential field.

31972 **Measurement of H and H_2 populations in a low-temperature plasma by vacuum ultraviolet laser absorption spectroscopy.** Young, A.T. (Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Stutzin, G.C.; Schlachter, A.S.; Stearns, J.W.; Leung, K.N.; Kunkel, W.B.; Worth, G.T.; Stevens, R.R. *AIP Conference Proceedings (American Institute of Physics) (USA),* 191(1): 767-769 (20 Oct 1989). DOE Contract AC03-76SF00098. (CONF-8810399–: 4. international laser science conference, Atlanta, GA (USA), 2-6 Oct 1988).

A new technique, vacuum ultraviolet laser absorption spectroscopy, has been developed to quantitatively determine the absolute density of H and H_2 within a plasma. The technique is particularly well suited to measurement in a plasma, where high

charged particle and photon backgrounds complicate other methods of detection. The high selectivity and sensitivity of the technique allows for the measurement of the rotational-vibrational state distribution of H_2 as well as the translational temperature of the atoms and molecules. The technique has been used to study both pulsed and continuous plasma discharges. H_2 state distributions show a high degree of internal excitation, with levels up to v=5 and J=8 being observed. Hydrogen atom measurements indicate that, even for modest discharge currents, the fraction of H_2 molecules dissociated can be greater than 0.15.

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Refer also to citation(s) 30654, 30657, 30827, 31046, 31131, 31133, 31188, 31230, 31687, 31688, 31820, 31954, 31955, 31958, 31961

31973 (ANL/FPP/TM–246) **International Thermonuclear Experimental Reactor (ITER) divertor plate performance and lifetime considerations.** Mattas, R.F. Argonne National Lab., IL (USA). Fusion Power Program. Mar 1990. 51p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90010277. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The ITER divertor plate performance during the technology phase of operation has been analyzed. High-Z materials, such as tungsten and tantalum, have been considered as plasma side materials, and refractory metal alloys, Ta-10W, TZM, Nb-1Zr, and V-15Cr-5Ti, plus copper alloys have been considered as the structural materials. The fatigue lifetime have been predicted for structural plates and for duplex plates with the plasma side material bonded to the structure. The results indicate that refractory alloys have a comparable or improved performance to copper alloys. Peak allowable heat fluxes for these analyses are in the range of 15–20 MW/m^2 for 2 mm thick structural plates and 7–11 MW/m^2 for 4 mm thick duplex plates. 4 refs., 55 figs., 6 tabs.

31974 (ANU-PRL-PP–89/5) **H-1 design and construction.** Hamberger, S.M.; Blackwell, B.D.; Sharp, L.E.; Shenton, D.B. Australian National Univ., Canberra (Australia). Plasma Research Lab. 1989. 11p. Order Number DE90625559. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

H-1 is a 3-field period medium-sized heliac (R_o = 1 m, r = 0.22 m, B_o = 1 T) nearing completion at the Australian National University, Canberra, and intended for basic plasma physics studies, including finite β effects in toroidal confinement systems. Its design allows a wide range of 'current-free' magnetic configurations to be explored for their properties of equilibrium and stability. 8 refs., 9 figs.

31975 (CNIC–00276) **Study of X-ray dose profile produced by HT-6M tokamak.** Yin Xiejin (Academia Sinica, Hefei, AH (China). Inst. of Plasma Physics); Zhang Huaixian; Liu Huijun; Wang Mingqing; Zheng Lizhen; Li Yuxiong; Liu Zhengqing. China Nuclear Information Centre, Beijing, BJ (China). Dec 1988. 7p. (In Chinese). (ASIPP–006). Order Number DE90626601. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The X-ray dose profile produced by HT-6M Tokamak covered in operation was studied. The measurement shows that X-ray is a continuous spectrum covered rather wider energy range, and its intensity varies with place and direction. The dose on the vacuum vessel is larger and ranges from 2.3 x 10^2 mSv to 1.6 x 10^4 mSv, while the dose in the hall, outside two meters from the torus surface, is 0 $\approx$ 1.8 x 10^2 mSv. The number of photon with energy below 500 keV is about 85 percent of the total. The information given here provides necessary basis of protection and safety estimation for normal device operation.

31976 (CONF-891204–30) **Effects of the primary recoil spectrum on microstructural evolution.** Wiedersich, H. Argonne National Lab., IL (USA). Nov 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989. Order Number DE90010472. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

For quantitative predictions and comparisons of microstructures that evolve during exposure to different radiation environments at elevated temperature one needs to develop methods that go beyond those based on the number of displacements per atom. The number of freely migrating defects that contribute to the microstructural development is far less than the total number of defects produced, as has been recognized for some time from measurements of radiation-induced segregation and of radiation-enhanced diffusion. One major reason for the small amount of defects available for long range migration is the high concentration and close spatial correlation of vacancies and, to a somewhat lesser degree, of interstitials in cascades produced by high energy knock-ons. As a consequence, many defects either recombine or form immobile defect clusters during the defect formation and cooling phases of the cascades. After doses exceeding a few tenths of a displacement per atom, the residue of small clusters and dislocation loops of vacancy type remaining in the central portions of energetic cascades and subscascades, is the second major reason for the reduction of the mean free path of defects between creation and annihilation. Defect production in various neutron and ion irradiation environments is discussed in light of these facts. A method to calculate the fraction of freely migrating defects from the cluster size distribution of defects produced in cascades is suggested. The results are in good agreement with available data. 22 refs., 5 figs.

31977 (CONF-891204–31) **Investigations of hydrogen/Li_2O surface interactions via quantum chemical cluster methods.** Tam, S.W.; Wright, J.; Curtiss, L.A.; Johnson, C.E. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989. Order Number DE90010407. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Both in-reactor and laboratory experiments on ceramic breeder materials have indicated that substantial enhancement of tritium release rate results when small amounts of H_2 (~0.1%) are added to the He purge gas stream. Although a comprehensive understanding of this empirical fact is still lacking, it is expected that surface processes would play a major role in the release process. Despite its significant improvement in tritium release in ceramic breeders, the interaction of hydrogen with lithium containing oxide ceramic surfaces is still poorly understood. If previous experience from nonmetallic catalysts can serve as a useful guide, the problem is likely to be non-trivial. At issue here is a sound physical-chemical description of the role played by hydrogen in enhancing tritium release. Only from such an understanding can one construct realistic models for the tritium release/inventory phenomena which have the reliability and predictive capability that are necessary for fusion reactor design in general and blanket design in particular. 17 refs., 3 figs.

31978 (CONF-891204–32) **Molecular dynamics studies of displacement cascades.** Averback, R.S. (Illinois Univ., Urbana, IL (USA). Dept. of Materials Science and Engineering); Hsieh Horngming, La Rubia, T. Diaz de; Benedek, R. Argonne National Lab., IL (USA). Feb 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989. Order Number DE90009716. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Molecular-dynamics simulations of cascades in Cu and Ni with primary-knock-on energies up to 5 keV and lattice temperatures in the range 0 K–700 K are described. Interatomic forces were represented by either the Gibson II (Cu) or Johnson-Erginsoy (Ni) potentials in most of this work, although some simulations using "Embedded Atom Method" potentials, e.g., for threshold events in Ni_3Al, are also presented. The results indicate that the primary state of damage produced by displacement cascades is controlled by two phenomena, replacement collision sequences during the collisional phase of the cascade and local melting during the thermal spike. As expected, the collisional phase is rather similar in Cu and Ni, however, the thermal spike is of longer duration and has a more pronounced influence in Cu than Ni. When the ambient temperature of the lattice is increased, the melt zones are observed to both increase in size and cool more slowly. This has the effect of reducing defect production and enhancing atomic mixing and disordering. The implications of these results for defect production,

cascade collapse, atomic disordering will be discussed. 34 refs., 7 figs., 2 tabs.

31979 (DOE/DP–0078T) **Status of target physics for inertial confinement fusion: Report on the review at DOE Headquarters, Germantown, MD on November 14–17, 1988.** InterScience, Inc., Troy, NY (USA). 9 Mar 1990. 36p. Sponsored by U.S. DOE Defense Programs. Order Number DE90008221. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A four day review to assess the status of target physics of inertial confinement fusion was held at US Department of Energy (DOE) Headquarters on November 14–17, 1988. This review completes the current series of reviews of the inertial fusion program elements to assess the status of the data base for a decision to proceed with the proposed Laboratory Microfusion Facility (LMF) that is being planned. In addition to target physics, the program elements that have been reviewed previously include the driver technology development for KrF and solid-state lasers, and the light-on beam pulsed power system. This series of reviews was undertaken for internal DOE assessment in anticipation of the ICF program review mandated by the Congress in 1988 to be completed in 1990 to assess the significance and implications of the progress that has been realized in the laboratory and the underground Halite/Centurion experiments. For this target physics review, both the direct and the indirect drive approaches were considered. The principal issues addressed in this review were: Is the present target physics data base adequate for a decision to proceed with design and construction of LMF now as opposed to continue planning activities at this time? What specific additional target physics data are desirable to reduce the risk for a DOE decision to construct an LMF? What is the role for continuation of Halite/Centurion experiments? What priority should be given to the direct drive approach? Are the program elements optimally structured to resolve the critical issues for an LMF decision? Specific findings relating to these five issues are summarized in the following.

31980 (DOE/ER/53263–8) **Workshop on high power ICH antenna designs for high density tokamaks: Summary and recommendations.** Aamodt, R.E. (ed.). Lodestar Research Corp., Boulder, CO (USA). 21 Feb 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER53263. (LRC–90-13;CONF-900169–2: ICH design workshop, Boulder, CO (USA), 31 Jan - 2 feb 1990). Order Number DE90010519. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A workshop in high power ICH antenna designs for high density tokamaks was held in Boulder, Colorado on January 31 through February 2, 1990. The purposes of the workshop were to: (1) review the data base relevant to the high power heating of high density tokamaks; (2) identify the important issues which need to be addressed in order to ensure the success of the ICRF programs on CIT and Alcator C-MOD; and (3) recommend approaches for resolving the issues in a timely realistic manner. Some specific performance goals for the antenna system define a successful design effort. Simply stated these goals are: couple the specified power per antenna into the desired ion species; produce no more than an acceptable level of rf auxiliary power induced impurities; and have a mechanical structure which safely survives the thermal, mechanical and radiation stresses in the relevant environment. These goals are intimately coupled and difficult tradeoffs between scientific and engineering constraints have to be made.

31981 (GA-A–19922) **DIII-D research operations annual report, October 1, 1988–September 30, 1989.** Politzer, P. (ed.). General Atomics, San Diego, CA (USA). Apr 1990. 139p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER51114. Order Number DE90008232. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This paper discusses research at the DIII-D tokamak reactor. The general topics covered in this report are: confinement; boundary physics; beta and stability; rf heating; current drive; ITER/CIT contributions; operations; tokamak operations; neutral beam operations; ECH/ICH operations; shielding radiation studies; transport diagnostics; advanced divertor; 110 GHz ECH system, fast wave current drive; pellet injector; collaborative work on DIII-D; international cooperation; quality assurance; planning & control; computer operations and safety.

31982 (GSI–84-16) **Investigation of stability problems in fusion by heavy-ion-induced inertial confinement.** Buchwald, G. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.); Frankfurt Univ. (Germany, F.R.). Fachbereich 13 Physik. Oct 1984. 122p. (In German). Order Number DE90784792. Available from NTIS (US Sales Only), PC A06/MF A01.

For thermonuclear ignition an optimized pellet implosion is necessary without destruction of the pellet's spherical symmetry and early breaking of the pellet e.g. by hydrodynamic instabilities like the Rayleigh-Taylor instability or by disadvantageous beam geometry. While the HIBALL Study realizes only 10^0 beam angle, the investigations in this work yield an optimized beam angle of 33^0. The sensitivity of an accelerated pellet layer against Rayleigh-Taylor instabilities also has been investigated. The author showed that a disturbance grows significantly slower than can be estimated by a linear analytical model because of vortices together with Kelvin-Helmholtz instabilities. The calculations show that the development of a Rayleigh-Taylor instability strongly depends on the shape of the initial disturbance. Secondary effects like the appearance of a second RTI-generation were observed numerically for the first time. For grain disturbances a critical layer thickness is determined for highest growth rate showing a weak maximum. Damping of the RTI growth rate by smearing over the boundary layer and by the influence of viscosity is found. (orig.).

31983 (Juel-Spez–337) **Stress analysis of the vacuum vessel of the TEXTOR neutral particle injector.** Butzek, D.A.; Graudus, E.; Sievers, A. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralabteilung Allgemeine Technologie; Association Euratom-Kernforschungsanlage Juelich GmbH (Germany, F.R.). Dec 1985. 50p. (In German). Available from Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek.

A stress analysis of the vacuum vessel of the TEXTOR-Neutral-Injector has been carried out. The loads on the vessel are caused by atmospheric pressure on the outer surfaces and metal sealing forces on the flanges. Besides classical methods (e.g. flange calculations with the DIN-rules) comprehensive calculations with the finite element code FEMFAM-F were executed. HP-desktop computers and the IBM-computer of the KFA were used interconnected by the data transfer system JOKER. The maximum reference stresses are 191 N/mm^2, the maximum deflection is 4,15 mm. (orig.).

31984 (KFK–4603) **On the mode-competition of high power gyrotrons operating in rotationally symmetric modes.** Joedicke, B. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Technische Physik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Kernfusion; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Elektrotechnik. Dec 1989. 140p. (In German). Order Number DE90785127. Available from NTIS (US Sales Only), PC A07/MF A01.

The gyrotron has proven to be a powerful source in the millimeterwaves region. However fusion application calls for more power per tube. Therefore highly overmoded resonators are required, with a vary dense mode spectrum, which leads to mode-competition. The influence of external parameters - such as the electron beam, magnetic field and load - on mode competition has been investigated theoretically and experimentally. It could be shown, that even in a dense mode spectrum single-mode operation of a gyrotron is possible. Due to the optimized startup conditions high-power single-mode oscillation could be achieved in the KfK 150 GHz gyrotron experiment. In the appendices a self-consistent multimode theory is developed and the problems in numerically solving the differential equations of the gyrotron are investigated. (orig.).

31985 (SAND–90-0396) **Plasma-facing materials.** Gauster, W.B. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008243. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The interaction of plasmas with materials is reviewed and a status summary is given based on experience in large fusion experiments, laboratory investigations, and design studies. The phenomena that are discussed limit the power densities and confinement properties attainable in plasmas; their control is an essential element of the design of future fusion devices. 31 refs., 2 figs., 1 tab.

31986 (SAND–90-0552C) **Data analysis for the Rutherford magnetic spectrograph on PBFA-II.** Kensek, R.P.; Lee, J.R.; Leeper, R.J.; Johnson, D.J.; Lockner, T.R.; Maenchen, J.; Mix, L.P.; Stygar, W.A.; Hebron, D.E.; Wenger, D.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900557–3: 8. topical conference on high-temperature plasma diagnostics, Hyannis, MA (USA), 6-10 May 1990). Order Number DE90009739. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A magnetic spectrograph employing a gold Rutherford scattering foil has been constructed and fielded on Sandia National Laboratories' PBFA-II accelerator to diagnose intense ion beams. The instrument simultaneously records time-integrated data on nuclear track recording film, CR-39, and time-resolved data on a set of PIN diodes. The details of the analysis of this data to provide time-resolved power density, ion current density, ion energy spectra (including mean ion energy), and ion species identification will be presented. 8 refs., 6 figs.

31987 (SAND–90-0631C) **Visible spectroscopy measurements in the PBFA II [Particle Beam Fusion Accelerator] ion diode.** Bailey, J. (Sandia National Labs., Albuquerque, NM (USA)); Carlson, A.L.; Morrison, R.L.; Maron, Y. Sandia National Labs., Albuquerque, NM (USA). [1990]. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900557–4: 8. topical conference on high-temperature plasma diagnostics, Hyannis, MA (USA), 6-10 May 1990). Order Number DE90010828. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We describe a new visible spectroscopy diagnostic system for measuring plasma properties in the PBFA II applied-B ion diode. The system transports light from the ion diode to a remote screen room where it is recorded by a spectrography coupled to a streak camera. We developed extensive calibration techniques for measuring the collection efficiency into the fiber link, the effects of the background bremsstrahlung radiation on the fibers, the fiber transmission as a function of wavelength, and the absolute streaked-spectrograph sensitivity as a function of wavelength. We have recorded time-dependent spectral line profiles and intensities from the PBFA II plasma opening switch, the beam-transport gas cell, and the anode plasma. The Stark shift of the LiI 2s-2p transition observed on LiF-anode shots shows that the time-resolved electric field peaks at 7–8 MV/cm, the highest field ever measured using the Stark effect. The potential of these measurements to expand our knowledge of ion-diode physics is being explored. 24 refs., 8 figs.

31988 (UCID–21849) **Electrical power from inertial confinement fusion: Issues and prospects.** Tobin, M.T.; Pitts, J.H.; Orth, C.D.; Moir, R.W.; Hogan, W.J.; Bangerter, R.O. Lawrence Livermore National Lab., CA (USA). Oct 1989. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010200. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the following topics on using inertial confinement for electrical power generation: General Economic Issues; Design of Reactors; Safety and Environmental Issues; and Development Issues.

31989 Development of 2-D hydrodynamic code for spherical plasma shell. Kawata, S. (Plasma Physics Research Institute, Univ. of California Davis, and Lawrence Livermore National Lab., Livermore, CA (US)); Masubuchi, Y. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Conservation equations of mass, momentum and energy are solved by using a control volume method with an equation of state. For example, mass conservation $\delta\rho/\delta t + \nabla\rho v = 0$ is rewritten by integrating over a volume V whose surface is denoted by S. $d\int_v \rho/dt = dM/dt = -\int_s \rho(v - \omega)ds$. Here the authors define ω as a velocity of S, that is, a mesh velocity and ω is arbitrary. They can choose an appropriate value for a specified problem. If the mesh velocity is zero, then the scheme becomes Euler method and if $\omega = v$, it is the Lagrange method. For a problem in which a mesh distortion is severe, they can choose ω so that meshes do not overtake each other. For the energy equation, they use the same method. This paper presents a simulation result for an imploding plasma shell irradiated by proton beams with the nonuniformity of 6% of beam intensity. A two dimensional hydrodynamic code HALLEY2D for an analysis of spherical plasma shell is presented.

31990 Nuclear fusion. Fowler, T.K. (Dept. of Nuci. Eng., California Univ., Berkeley, CA (US)). *Journal of Acoustic Emission (USA),* 8(2): 7-10 (May 1989).

The advantages of nuclear fusion as an energy source and research progress in this area are summarized. The current state of the art is described. Laser fusion, inertial confinement fusion, and magnetic fusion (the tokamak) are explained, the latter in some detail. Remaining problems and planned future reactors are considered. They are the compact ignition tokamak (CIT), the international thermonuclear experimental reactor (ITER), and TIBER II. The design of the latter is shown.

31991 Signal enhancement in collinear four-wave mixing. McKinstrie, C.J. (Laboratory for Laser Energetics, 250 East River Road, Rochester, New York 14623 (US)); Luther, G.G.; Batha, S. *Journal of the Optical Society of America, Part B: Optical Physics (USA),* 7(3): 340-344 (Mar 1990). DOE Contract FC03-85DP40200.

The solitary-wave solutions of the four-wave equations are studied, and their relevance to four-wave mixing in finite media is discussed. In general, the transfer of action from the pump waves to the probe and signal waves is limited by nonlinear phase shifts that detune the interaction. However, by controlling the linear phase mismatch judiciously, it is often possible to effect a complete transfer of action from the pump waves to the probe and signal waves.

31992 Influence of a biased beam dump on H^- beam neutralization measurements with a four-grid energy analyzer. Sherman, J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Pitcher, E.; Allison, P. *Review of Scientific Instruments (USA),* 61(1): 616-618 (Jan 1990). DOE Contract AC03-76SF00098. (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A four-grid energy analyzer diagnostic has been developed for the study of H^- beam space-charge compensation, and first measurements have been reported previously. Biased beam-dump measurements were undertaken to clarify the origin of electron currents measured in the FGA because they far exceeded predictions based on H^--beam ionization and stripping processes. This experiment partially explains the anomalously large radial electron current. The FGA observations for negative beam-dump bias suggest electron ionization of the background gas is an additional mechanism for producing positive ions.

31993 High current negative ion sources (invited). Ehlers, K.W. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720 (US)). *Review of Scientific Instruments (USA),* 61(1): 662-664 (Jan 1990). (CONF-890703–: International conference on ion sources, Berkeley, CA (USA), 10-14 Jul 1989).

A brief historical survey is presented of the origin of negative ion sources and their application for tandem accelerators and for fusion. Present-day volume-production sources and surface-production negative ion sources are described.

31994 Low-preheat cryogenic implosion experiments with a shaped 0.53-μm laser pulse. Johnson, R.R.; Powers, L.V.; Failor, B.H.; Gabl, E.F.; Shepard, C.L.; Busch, G.E.; Hammerling, P.; Larsen, J.T.; Rockett, P.D.; Schroeder, R.J. *Physical Review, A (General Physics) (USA),* 41(2): 1058-1070 (15 Jan 1990). DOE Contract AC03-87DP10560.

Spherical implosion experiments have been performed using shaped laser pulses at λ_0=0.53 μm to illuminate deuterium-filled polyvinyl alcohol (PVA) spherical shells. The deuterium fuel was cryogenically cooled to form a uniform frozen fuel layer. Plasma diagnostics included time-resolved x-ray radiography and multiframe

holographic interferometry. These and other measurements in conjunction with hydrodynamic simulations establish the importance of shaped laser pulses in achieving high fuel compressions.

99 GENERAL AND MISCELLANEOUS

9901 Management

Refer also to citation(s) 30108, 30227, 30501, 30503, 30961, 30965, 31327, 31332

31995 (IAEA-WMRA–19) **Waste management research abstracts No.19: Information on radioactive waste programmes in progress.** International Atomic Energy Agency, Vienna (Austria). Jun 1989. 533p. Order Number DE90627132. Available from NTIS (US Sales Only), PC A23/MF A01; OSTI; INIS.

The research data sheets contained in this issue have been collected up to October 1988. Enquiries for further information concerning a particular data sheet should be addressed to the author(s) at his (their) institute. This issue contains over 840 abstracts that describe research in progress in the field of radioactive waste management. These abstracts present ongoing work in 33 countries and international organizations.

31996 (RISO-R–569) **Metallurgy Department. Annual progress report for 1988.** Schroeder Pedersen, A.; Bilde-Soerensen, J.B.; Hansen, N. (eds.). Risoe National Lab., Roskilde (Denmark). Metallurgy Dept. May 1989. 56p. Order Number DE90627147. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Selected activities of the Metallurgy Department at Risoe National Laboratory during 1988 are described. The work is presented in four chapters: Materials Science, Materials Engineering, Materials Technology and Energy Programmes. A survey is given of the Department's participation in international collaboration and of its activities within education and training. Furthermore, the main numbers illustrating the Department's economy are given. Lists of staff members, visiting scientists, publications, lectures and poster presentations are included. (author) 36 ills., 81 refs.

31997 (SAND–89-2727C) **Enhancing a relational database: Stepwise, bottom-up design.** Eaton, D.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005167–4: North American INGRES Users Association (NAIUA) conference, Salt Lake City, UT (USA), 6-10 May 1990). Order Number DE90010834. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Relational databases have gained in popularity over previous methods for many reasons. Users like them for their simplicity. Users and developers appreciate the data independence features of relational systems; details of storage structures and access strategies are left to the database software itself. Finally, relational databases, properly designed, can be easily modified for various new requirements or as a planned "bottom-up" design step toward a corporate information system. The enhancement described here consisted of changing a mainframe database containing information about companies to add another customer's information including current company, company address, and historical company data.

9902 Mathematics and Computers

Refer also to citation(s) 29936, 30040, 30041, 30042, 30043, 30048, 30108, 30145, 30185, 30271, 30272, 30277, 30282, 30332, 30349, 30368, 30375, 30377, 30393, 30403, 30429, 30430, 30519, 30521, 30559, 30560, 30567, 30593, 30596, 30640, 30659, 30680, 30687, 30689, 30695, 30900, 30907, 30951, 30958, 30959, 30963, 30964, 30979, 31001, 31067, 31127, 31131, 31132, 31177, 31188, 31279, 31283, 31287, 31291, 31299, 31300, 31309, 31314, 31323, 31328, 31329, 31339, 31412, 31417, 31419, 31562, 31709, 31745, 31816, 31858, 31916, 31917, 31919, 31921, 31951, 31952, 31956, 31989

31998 (AD-A–217062/9/XAB) **Parallel methods for solving nonlinear block-bordered systems of equations. Technical report, 1 September 1988-31 December 1989.** Zhang, X.; Byrd, R.H.; Schnabel, R.B. Colorado Univ., Boulder, CO (USA). Dept. of Computer Science. 31 Dec 1989. 39p. (CU-CS–454-89). Available from NTIS, PC A03/MF A01.

A group of parallel algorithms, and their implementation is discussed, for solving a special class of large sparse nonlinear equations. The type of sparsity occurring in these problems, which arise in VLSI design, structural engineering and many other areas, is called a block bordered structure. An explicit method and several implicit methods are described for solving block bordered nonlinear problems, and a mathematical analysis and computational comparisons are made for the two types of methods. Several variations and globally convergent modifications of the implicit method are also presented. Parallel algorithms for solving block bordered nonlinear equations are described and experimental results presented on the Intel hypercube that show the effectiveness of the parallel implicit algorithms. These experiments include a fairly large circuit simulation that leads to a multi-level block bordered system of nonlinear equations.

31999 (AD-A–217071/0/XAB) **Parallel (//) ELLPACK: An expert system for parallel processing of partial differential equations.** Rice, J.R. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. Oct 1989. 13p. Available from NTIS, PC A03/MF A01.

Pub. in Mathmatics and Computers in Simulation, Vol. 31, No. 4-5, 497-507(Oct 1989).

We are developing an expert system environment for solving elliptic partial differential equations (PDEs) defined on two and three dimensional domains on MIMD type parallel machines. According to its design objectives, it will provide a uniform programming environment for implementing parallel MIMD PDE solution solvers, an automatic partitioning and allocation of the PDE computation, a very high level problem specification language, an interactive high level environment for grid selection, a domain partitioning and mapping facility, a uniform environment for obtaining software engineering measurements and a graphical display of solution output. The ELLPACK is implemented on a hardware facility consisting of a graphics workstation supporting X11 window system and connected to NCUBE and SEQUENT machines through a wide bandwidth local network. The software infrastructure includes (i) a PDE problem oriented language processor, (ii) a geometry processing tool which is capable of generating fixed meshes and domain decompositions automatically and interactively, (iii) an algorithm mapper facility for partitioning and mapping the underlying PDE computation and (iv) and expert front end that selects the discretization mesh, the parallel algorithm/machine pair and its configuration. In order to support the solution of elliptic PDEs on fixed meshes, we are building a library of finite difference and element discretization methods and direct/iterative solvers for the NCUBE and SEQUENT machines.

32000 (AD-A–217072/8/XAB) **Parallel spline collocation-capacitance method for elliptic partial differential equations.** Christara, C.C.; Houstis, E.N.; Rice, J.R. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 1989. 11p. Available from NTIS, PC A03/MF A01.

Pub. in 1988 International Conference on Supercomputing, 375-385(1989).

Consider the integration of a domain decomposition technique with a new quadratic spline collocation discretization scheme for solving second order elliptic boundary value problems on rectangles. The domain decomposition method is based on the capacitance matrix technique. Due to the limitations of existing methods for solving the corresponding capacitance problem, we develop and analyze iterative methods for its solution. The optimum partitioning and mapping of the underlying computation is studied on hypercube architectures. A numerical realization of this method is presented on NCUBE/7 (128 processors) and its comparative efficiency is measured. The resulting parallel quadratic spline collocation-capacitance method is seen to be efficient in achieving accurate solutions and in using parallel architectures.

32001 (AD-A–217093/4/XAB) **Adaptive, asynchronous stochastic global optimization algorithms for sequential and**

parallel computation. Technical report, 1 September 1988-31 August 1989. Smith, S.; Eskow, E.; Schnabel, R.B. Colorado Univ., Boulder, CO (USA). Dept. of Computer Science. 26 Oct 1989. 31p. (CU-CS–449-89). Available from NTIS, PC A03/MF A01.

We discuss new global optimization algorithms that are related to the stochastic methods of Rinnooy Kan and Timmer, and to our previous static, synchronous parallel version of this method. The new algorithms have two main new features. First, they adaptively concentrate the computation in the areas of the domain space that appear most likely to produce the global minimum. Secondly, on parallel computers, they use an asynchronous approach, combined with a central work scheduler, to avoid load balancing problems. We investigate several mechanisms for deciding when and how to make the adaptive adjustments. We also describe both algorithmic and implementation considerations involved in constructing the parallel asynchronous algorithm. Computational tests on sequential and parallel computers show that the adaptive and asynchronous features of our new method can substantially reduce the number of function evaluations, and the execution time, required by previous stochastic methods to solve global optimization problems.

32002 (AD-A–217126/2/XAB) **Locality-based multiprocessor cache interference model.** Agarwal, A. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Oct 1989. 10p. (VLSI-MEMO–89-565). Available from NTIS, PC A02/MF A01.

Keeping data consistent in cache-coherent multiprocessors often requires the invalidation of cached blocks and results in higher miss rates. The increase in the cache miss rate due to invalidations is related to the number of processors and to the level of sharing. Analytically modeling this increase is important for the accurate performance evaluation of cache-based multiprocessors. Previous modeling efforts assumed a uniform probability of access to shared blocks. However, applications that we have studied show significant temporal locality of access to shared blocks, which substantially alters the magnitude of sharing related misses. This paper develops a multiprocessor cache interference model using temporal locality information measured from address traces of parallel applications. The model is very simple and yields reasonable predictions.

32003 (AD-A–217148/6/XAB) **Modeling hardware-software interactions in parallel and distributed systems using stochastic high-level Petri nets.** Marinescu, D.C.; Rice, J.R. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 1 Mar 1989. 9p. Available from NTIS, PC A02/MF A01.

Pub. in Distributed Processint Technical Committee Newsletter, Vol. 10, No. 1, 28-34(1 Mar 1988).

The ability to model the iteration between the hardware and the software components of a system is extremely useful in distributed system design, real-time system analysis, parallel algorithm design, and several other significant areas of research. Non-deterministic performance analysis of such interactions carried out using simulation methods, queueing analysis or hybrid methods, becomes prohibitively expensive for systems of any practical interest.

32004 (AD-A–217300/3/XAB) **Parallel computer graphics algorithms for the Connection Machine.** Richardson, J.F. Naval Ocean Systems Center, San Diego, CA (USA). Jan 1990. 26p. Available from NTIS, PC A03/MF A01.

Many of the classes of computer graphics algorithms and polygon storage schemes can be adapted for parallel execution on various parallel architectures. The connection machine is one such architecture that should be thought of as a multiprocessor grid that can be reconfigured into standard 2-dimensional mesh and n-dimensional hypercube architectures. The classes of algorithms considered in this paper are SPLINES; POLYGON STORAGE; TRIANGULARIZATION; and SYMBOLIC INPUT. The target Connection Machine (hearafter designated as CM) for the algorithms of this paper has 8192 physical processors. Each physical processor has 8 kilobytes of local memory plus an arithmetic-logic unit. All processors can communicate with any other processor through a router. Thus this CM has a shared memory of 64 megabytes when used as a standard multiprocessor (MIMD) architecture. In addition, the CM interconnection structure can simulate a 2-dimensional mesh and n-dimensional hypercube (SIMD) architecture with the mesh being the default architecture. The front end for the CM is a Symbolics and the high level language is LISP or FORTRAN.

32005 (AD-A–217393/8/XAB) **Artificial Intelligence (AI) Center of Excellence at the University of Pennsylvania. Final report, July 1984-September 1989.** Joshi, A.; Bajcsy, R.; Badler, N.; Buneman, P.; Webber, B. Pennsylvania State Univ., University Park, PA (USA). Coll. of Mineral Industries. Oct 1989. 83p. Available from NTIS, PC A05/MF A01.

The five major research thrusts are: Natural language processing; Machine perception and robotics; Task oriented computer animation; Programming structures for databases and knowledge bases; and Parallel processing in AI. We describe these capabilities by combining some past work and directions of new work under progress.

32006 (AD-A–217421/7/XAB) **Asynchronous design for parallel-processing architectures. Semi-annual report, July 1989-December 1989.** Meng, T.H. Stanford Univ., CA (USA). Dec 1989. 2p. Available from NTIS, PC A01/MF A01.

The objective of this research is to provide an interconnect design synthesis methodology which facilitates a modular design approach without compromising the global performance. The main tasks of this effort will be the development of the theory for optimal interconnect synthesis from a high-level specification, with emphasis on testability and fault-tolerance asynchronous interface among parallel-computing-hardware objects, and the application of this design methodology to physical implementations of multiprocessing systems.

32007 (AD-A–217424/1/XAB) **Optimal selection theory for superconcurrency. Professional paper.** Freund, R.F. Naval Ocean Systems Center, San Diego, CA (USA). Nov 1989. 6p. Available from NTIS, PC A02/MF A01.

This paper describes a mathematical programming approach to finding an optimal, heterogeneous suite of processors to solve supercomputing problems. This technique, called superconcurrency, works best when the computational requirements are diverse and significant portions of the code are not tightly-coupled. It is also dependent on new methods of benchmarking and code profiling, as well as eventual use of AI techniques for intelligent management of the selected superconcurrent suits.

32008 (AD-A–217489/4/XAB) **Analysis of a two-level asynchronous algorithm for PDEs (partial differential equations).** Rice, J.R.; Marinescu, D.C. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 1989. 13p. Available from NTIS, PC A03/MF A01.

Pub. in Aspects of Computation on Asynchronous Parallel Processors, 23-33(1989).

A two-level asynchronous algorithm for partial differential equations is presented in this reprint. An analysis of the algorithm and of its implementation on a hypercube shows that the algorithm has several desirable properties; its speedup increases as the number of grid points grows, it is stable with respect to load-imbalance effects, and it is well suited for parallel machines with relatively slow communication.

32009 (AD-A–217625/3/XAB) **Model for monitoring and debugging parallel and distributed software.** Marinescu, D.C.; Lumpp, J.E.; Casavant, T.L.; Siegel, H.J. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 1989. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Annual International Computer Software and Applications Conference, 81-88(1989).

Several aspects of the multidimensional problem of providing monitoring support for the debugging and performance analysis of distributed and parallel systems and parallel applications are presented. The key elements of the solution to the problem are a formal event-action model at the process level and a layered architectural model. The application of the event-action model to the development of the abstract layered architectural model is shown as well as a proposed implementation sketch of a non-intrusive monitor for the PASM parallel processing system.

32010 (AD-A–217626/1/XAB) **Safe-state approach to real-time system scheduling.** Marinescu, D.C.; Szpankovski, W.

Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 12 May 1989. 9p. Available from NTIS, PC A02/MF A01.

Pub. in IEEE Workshop on Real-Time Operating Systems and Software (6th) 54-60(11-12 May 1989).

This paper discusses nondeterministic scheduling for real-time systems serving a mix of tasks, some with deadlines to the beginning of service and some with deadlines to the completion of service. Some of the tasks may have, in addition to a deadline, some form or other of priorities associated with their execution. The authors propose treating all these cases uniformly by determining an estimated extinction time, defined as the latest time a task with a deadline and priority must begin its execution, and then to schedule the task according to some policy based upon its estimated extinction time.

32011 (AD-A-217682/4/XAB) **Supercomputer environments. Final technical report, October 1986-October 1989.** Guarna, V.A. Illinois Univ., Urbana, IL (USA). 9 Jan 1990. 35p. Available from NTIS, PC A03/MF A01.

The objective of the Faust project is to provide users of high-performance parallel and vector machines with an environment that makes the task of programming easier. This includes tools that are used in the process of developing, testing, tuning, and using scientific and engineering programs. Many of these tools are specific to the problem of parallel programming such as restructuring compilers, parallel debuggers, and parallel program performance evaluation tools, as well as tools that are useful in any program development environment such as text editors, program management assistants, on-line documentation systems, and graphic visualization tools. The first major goal is the design and implementation of a set of new tools aimed specifically at the problem of developing efficient scientific programs for supercomputers. The second goal is portability. Although the Faust environment assumes the existence of a bitmapped workstation running Unix as a basic platform, Faust is expected to run a variety of hardware. To accomplish this goal, all user interface libraries have been layered on top of the X Window System developed at MIT. The third goal is integration.

32012 (ANL/TM-475) **The CERC [Center for Energy Research Computation] report: Results of the CERC Project with recommendations for ANL [Argonne National Laboratory] institutional strategies in advanced scientific computing.** Mueller, C.J.; Caruthers, C.M.; Cowell, W.R.; Ellingson, W.A.; Ewing, T.F.; Moszur, F.M.; Harrison, R.J.; Leibfritz, D.W.; Malon, D.M.; May, E.N. Argonne National Lab., IL (USA). Jan 1990. 90p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90008238. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report discusses: investigations in computational science applications at Argonne; software tools for analysis and transformation of Fortran programs; scientific visualization projects and demonstrations; and institutional strategies in advanced scientific computing.

32013 (BNL-44517) **Design of decoupling for a class of right invertible systems.** Zhang, Wu (Brookhaven National Lab., Upton, NY (USA)); Chen, Chi-Tsong. Brookhaven National Lab., Upton, NY (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9005135-4: 1990 American control conference, San Diego, CA (USA), 23-25 May 1990). Order Number DE90010649. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper, a design algorithm of static state feedback decoupling for a class of right invertible systems is presented. The condition is described by system interactor, and the method is based on polynomial matrix fraction form. Examples are included. 13 refs.

32014 (CONF-891273-4) **A block QR factorization algorithm for rank-deficient matrices.** Bischof, C.H. Argonne National Lab., IL (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Grant ASC-8715728. From 4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989. Order Number DE90010066. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper presents a new algorithm for computing the QR factorization of a rank-deficient matrix that is well suited for high-performance machines. These machines typically employ a memory hierarchy and matrix-matrix operations perform better on those machines than matrix-vector or vector-vector operations since they require significantly less data movement per floating point operation. The traditional QR factorization algorithm with column pivoting is not well suited for such environments since it precludes the use of matrix-matrix operations. Instead, we suggest a restricted pivoting strategy based on incremental condition estimation which allows us to formulate a block QR factorization algorithm where the bulk of the work is in matrix-matrix operations. Performance results on the Cray 2, Cray X-MP and Cray Y-MP show that the new algorithm performs significantly better than the traditional scheme and can more than halve the cost of computing the QR factorization. 19 refs., 1 fig., 1 tab.

32015 (CONF-8906317-1) **Ground states of semi-linear diffusion equations.** Kaper, H.G.; Kwong, Man Kam. Argonne National Lab., IL (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Workshop on differential equations and applications; Retzhof (Austria); 18-24 Jun 1989. Order Number DE90010419. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This article is concerned with the uniqueness of nontrivial nonnegative solutions of semilinear diffusion equations of the type $\Delta u + f(u) = 0$ in radially symmetric domains in R^N ($N \geq 2$), where f is defined and continuous on $(0, \infty)$ and Lipschitz continuous on $(0, \infty)$, with $f(0) = 0$. 7 refs.

32016 (CONF-8910400-1) **On the performance of algorithms for large-scale bound constrained problems.** More, J.J. Argonne National Lab., IL (USA). Feb 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Workshop on large-scale numerical optimization; Ithaca, NY (USA); 19-20 Oct 1989. Order Number DE90010084. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We discuss issues that affect the performance of algorithms for the solution of large-scale bound constrained problems on parallel computers. The discussion centers on the solution of the elastic-plastic torsion problem and the journal bearing problem. These two problems are model large-scale quadratic programming problems that arise as finite element approximations to elliptic variational inequalities. Performance issues are illustrated with the GPCG algorithm of More and Toraldo. This algorithm uses the gradient projection method to select an active set and the conjugate gradient method to explore the active set defined by the current iterate. We show that significant improvements in the performance of the GPCG algorithm can be obtained by using partitioning techniques in a parallel environment. We also show that these partitioning techniques lead to almost linear speedups on function-gradient evaluations and Hessian-vector products for partially separable functions. 12 refs., 2 figs., 8 tabs.

32017 (CONF-8910400-2) **Direct calculation of Newton steps without accumulating Jacobians.** Griewank, A. Argonne National Lab., IL (USA). [1989]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Workshop on large-scale numerical optimization; Ithaca, NY (USA); 19-20 Oct 1989. Order Number DE90009702. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In the computational practice, nonlinear vector-functions whose roots need to be calculated are often specified in form of an evaluation program supplied by the 'user'. This program typically consists of one or more subroutines that compute values of the dependent variables given values of the independent variables. To this end the evaluation program usually generates a large number of intermediate quantities that are local variables and thus ordinarily not visible to the calling routine. By considering the intermediate quantities as additional independent variables one obtains an extended nonlinear system, which should be attacked directly because of the following desirable properties. The extended Jacobian is extremely sparse and can be evaluated at little extra cost simultaneously with the original vector function. The direct computation of the extended Newton-step by Gaussian elimination with suitable pivoting is never

more expensive and sometimes significantly cheaper than the calculation of the original Newton-step by forming and factoring the Jacobian. Moreover, it is shown that any method for computing Newton-steps on the original vector function is in terms of complexity equivalent to scheme for solving a linear system in the extended Jacobian. The conditioning of this large sparse matrix reflects not only the stability of the original vector function but also the accuracy of the evaluation algorithm. This allows the design of realistic stopping criteria without user supplied tolerances. 10 refs. , 4 figs.

32018 (CONF-8910401–1) **The HK singular value decomposition of rank deficient matrix triplets.** Ewerbring, L.M. (Argonne National Lab., IL (USA)); Luk, F.T. Argonne National Lab., IL (USA). [1989]. 7p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Grant-DAAL03-86-K-0109. From 1. Great Lakes computer science conference; Kalamazoo, MI (USA); 18-20 Oct 1989. Order Number DE90010114. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper we consider a simultaneous reduction of three matrices. The described method is extended from previous work to include rank deficient data. It is shown how, via an initial reduction, the problem becomes one of diagonalizing a product of three matrices. We compare three different algorithms for its computation and show why one is preferred over the others.

32019 (CONF-9004159–4) **Input/output algorithm for M-dimensional rectangular domain decompositions on N-dimensional hypercube multicomputers.** Embrechts, H. (Louvain Univ., Heverlee (Belgium). Dept. Computerwetenschappen); Jones, J.P. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990. Order Number DE90010494. Available from NTIS, PC A02/MF A01 - OSTI.

Hypercube-topology concurrent multicomputers owe at least part of their popularity to the fact that it is relatively simple to decompose rectangularly-shaped M-dimensional domains into subdomains and assign these subdomains to processors (PEs) in a manner which preserves the adjacencies of the subdomains. However, this decomposition involves some arrangement of the data during input/output operations to (linear memory) data acquisition, display, or mass storage devices. We show that this rearrangement can be done efficiently, in parallel. The main consequence of this algorithm is that M-dimensional data can be stored in a simple, general format and yet be communicated efficiently independent of the dimension of the hypercube or the number of these dimensions assigned to the dimensions of the domain. This algorithm is also relevant to applications with mixed domain decompositions, and to parallel mass storage media such as disk farms.

32020 (CONF-9006169–1) **Multiple specialization of logic programs with run-time tests.** Jacobs, D. (University of Southern California, Los Angeles, CA (USA)); Langen, A.; Winsborough, W. Argonne National Lab., IL (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38. Grant CCR-8807171. From 7. international conference on logic programming; Jerusalem (Israel); 18-21 Jun 1990. Order Number DE90010060. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper presents a framework for multiple specialization of logic programs that incorporates run-time testing. This framework supports specialization on the basis of a compiler-generated "wish list" of requirements that enable useful optimizations. In addition, entry mode declarations are used to restrict the class of reachable activations. Our goal is to generate code containing tests at outer levels of the call tree that guard high-performance specialized procedures that are likely to be called. The starting point for this work is the multiple specialization technique of Winsborough, which introduced the notion of a call-path automation. The transition function for a call-path automation specifies which version of a procedure should be invoked by each call in each version of each procedure. As a first step, we extend such automata to include "test arcs" that select different versions. We then show how to construct an automation containing a given set of tests at given test sites. Finally, we discuss techniques for abductively deriving a test at a given site that, upon success, ensures some property at a requirement site. 13 refs.

32021 (KFK–4582) **PROSID - a program to evaluate SIMMER-II results.** Flad, M. (DTI Dr. Trippe Ingenieurgesellschaft mbH, Karlsruhe (Germany, F.R.)); Kuefner, K.; Maschek, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schneller Brueter. Feb 1990. 99p. (In German). Order Number DE90785126. Available from NTIS (US Sales Only), PC A05/MF A01.

FORTRAN 77.

The PROSID program supports the evaluation of SIMMER-II results. PROSID enables the user to get a printout of variables, to get a linear combination of variables or quadrats of variables, to sum up variables or quadrats of variables, to compare variables or whole datasets, to interpolate to a new meshgrid and to get weighted mean values. As special options are available the calculation of the volume of connected gas regions, the evaluation of the fuel enrichment, an estimation of reactivity changes and the retransformation of interpolated velocity values. The results can be stored for further evaluations. (orig.).

32022 (PB–90-173667/XAB) **Data flow semantics.** Kok, J.N. Centrum voor Wiskunde en Informatica, Amsterdam (Netherlands). c 1988. 117p. (CWI-CS-R–8835). Available from NTIS, PC A06/MF A01.

The paper studies the semantics of data flow. First it assigns a history-based operational semantics to data-flow nets, which models a net as a function from inputs to sets of possible outputs. Moreover, it presents an alternative definition in which it associates with each node an automation. It introduces an intermediate semantics which is shown to be compositional by proving the intermediate semantics equivalent to denotational semantics, which is compositional by definition. It is also proved that the denotational semantics is fully abstract with respect to the operational semantics: it generates the greatest congruence which is contained in the equivalence relation generated by the operational semantics. It is shown that an alternative definition of the denotational semantics involves an (implicit) fixed point: a fixed point of a multivalued function (contain point) is taken. Some properties of contain points are given in a metric topological setting. These properties are used to show that for a restricted class of data flow nets there exists a metric compositional semantics in which the contain points can be obtained by iteration. It is called a metric semantics because the domains are metric spaces.

32023 (PNL–7247) **VISTA [Vertical Integration of Science, Technology, and Applications] user interface software study.** Chin, G. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90010003. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Vertical Integration of Science, Technology, and Applications (VISTA) project is an initiative to employ modern information and communications technology for rapid and effective application of basic research results by end users. Developed by the Pacific Northwest Laboratory, VISTA's purpose is to develop and deploy information systems (software or software/hardware products) to broad segments of various markets. Inherent in these products would be mechanisms for accessing PNL-resident information about the problem. A goal of VISTA is to incorporate existing, commercially available user interface technology into the VISTA UIMS. Commercial systems are generally more complete, reliable, and cost-effective than software developed in-house. The objective of this report is to examine the current state of commercial user interface software and discuss the implications of selections thereof. This report begins by describing the functionality of the user interface as it applies to users and application developers. Next, a reference model is presented defining the various operational software layers of a graphical user interface. The main body follows which examines current user interface technology by sampling a number of commercial systems. Both the window system and user interface toolkit markets are surveyed. A summary of the current technology concludes this report. 15 refs., 3 figs., 1 tab.

32024 (SAND–89-2930C) **Linear algebra for dense matrices on a hypercube.** Sears, M.P. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004159–6: 5. distributed memory computing conference, Charleston, SC (USA), 9-12 Apr 1990). Order Number DE90010533. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A set of routines has been written for dense matrix operations optimized for the NCUBE/6400 parallel processor. This work was motivated by a Sandia effort to parallelize certain electronic structure calculations. Routines are included for matrix transpose, multiply, Cholesky decomposition, triangular inversion, and Householder tridiagonalization. The library is written in C and is callable from Fortran. Matrices up to order 1600 can be handled on 128 processors. For each operation, the algorithm used is presented along with typical timings and estimates of performance. Performance for order 1600 on 128 processors varies from 42 MFLOPs (Householder tridiagonalization, triangular inverse) up to 126 MFLOPs (matrix multiply). We also present performance results for communications and basic linear algebra operations (saxpy and dot products). 8 refs., 6 tabs.

32025 (SAND–90-0566) **GREPOS: A GENESIS database repositioning program.** Sjaardema, G.D. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90010254. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

GREPOS is a mesh utility program that repositions or modifies the configuration of a two-dimensional or three-dimensional mesh. GREPOS can be used to change the orientation and size of a two-dimensional or three-dimensional mesh; change the material block, nodeset, and sideset IDs; or "explode" the mesh to facilitate viewing of the various parts of the model. GREPOS also updates the EXODUS Quality Assurance (QA) and information records to help track the codes and files used to generate the mesh. GREPOS reads and writes two-dimensional and three-dimensional mesh databases in the GENESIS database format; therefore, it is compatible with the preprocessing, postprocessing, and analysis codes used by the Engineering Analysis Department at Department at Sandia National Laboratories (SNL).

32026 (SOL–90-4) **A build-up interior method for linear programming: Affine scaling form.** Dantzig, G.B.; Yinyu Ye. Stanford Univ., CA (USA). Systems Optimization Lab. Feb 1990. 29p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract FG03-87ER25028. Grant DDM-8814253;Grant DMS-8913089;Grant N00014-89-J-1659. Order Number DE90010878. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We propose a build-up interior method for solving an m equation n variable linear program which has the same convergence properties as their well known analogues in dual affine and projective forms but requires less computational effort. The algorithm has three forms, an affine scaling form, a projective scaling form, and an exact form. In this paper, we present the first of these. It differs from Dikin's algorithm of dual affine form in that the ellipsoid chosen to generate the improving direction $\bar{\Delta}$ in dual space is constructed from only a subset of the dual constraints. At the start of each major iteration t, we are given an interior iterate y^t. A selection of m dual constraints is being made using an "order-columns" rule as to which constraints show "the most promise" of being tight in the optimal dual solution. An ellipsoid centered at y^t is then inscribed in convex region defined by these promising constraints and an improving direction $\bar{\Delta}$ computed that points to the optical point $y^t + \bar{\Delta}$ on the ellipsoid boundary. Minor cycling within a major iteration is then started. During a minor cycle, the constraints selected to define the ellipsoid centered at y^t is built up to include the constraint that first blocks feasible movement from y^t to $y^t + \bar{\Delta}$. If one blocks, it is used to augment the set of promising constraints and the ellipsoid is revised; the improving direction $\bar{\Delta}$ is recomputed by means of a rank-one update, and the minor cycle repeated until none blocks movement from y^t to $y^t + \bar{\Delta}$. When none blocks, the minor cycling ends. $y^{t+1} = y^t + \bar{\Delta}$ initiates the next major iteration. Major iterations stop when an optimum solution is reached. We prove this will occur in a finite number of iterations.

32027 (UCRL-JC–103441) **The ALPAL Matrix Editor for symbolic Jacobians.** Painter, J.F. Lawrence Livermore National Lab., CA (USA). Apr 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004189–1: 2. international conference for expert systems in numerical analysis, West Lafayette, IN (USA), 24 Apr 1990). Order Number DE90010639. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

ALPAL is a tool that automatically generates code to solve nonlinear integro-differential equations, given a very high-level specification of the equations to be solved and the numerical methods to be used. Its Matrix Editor is brought into play when an ALPAL user wants to use an implicit time-integration scheme. The Matrix Editor is a graphical, interactive tool for specifying the handling of Jacobian matrices and linear solvers. Such specification is done at a very high level of abstraction, and is applied to symbolically defined Jacobian matrices. 4 refs., 2 figs.

32028 (UCRL-JC–103580) **Preconditioned time-differencing for the parallel solution of the heat equation.** Rodrigue, G. (California Univ., Davis, CA (USA)); Wolitzer, D. Lawrence Livermore National Lab., CA (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891273–5: 4. SIAM conference on parallel processing for scientific computing, Chicago, IL (USA), 11-13 Dec 1989). Order Number DE90010636. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper we derive a new explicit difference method for solving the multidimensional heat equation. This method will be first order accurate in time and second order accurate in space and will have stability regions that are greater in size than the classical explicit Euler schemes. The motivation behind the development of new explicit methods is the fact that they can be efficiently carried out on vector and parallel computers. Thus, even though explicit methods are only conditionally stable, they may be more effective in use than the unconditionally stable implicit methods provided the stability intervals of the explicit methods are not too small. 5 refs., 1 fig., 2 tabs.

32029 (UCRL-MA–103420) **Security Profile Inspector (SPI) for the VMS operating system requirements specifications document.** King, M.E. Lawrence Livermore National Lab., CA (USA). 1 May 1989. 39p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010680. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This requirements specification document provides a general description and the functional requirements of the Security Profile Inspector (SPI) project for the VMS operating system. This document provides a guideline for the software design and implementation of SPI/VMS. 8 refs.

32030 (UCRL-MA–103421) **SPI/VMS user manual: Version 1.0.** King, M.E. Lawrence Livermore National Lab., CA (USA). 12 Mar 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010693. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This manual explains how to use the Security Profile Inspector for the VMS operating system (SPI/VMS) to detect potential security problems. This manual provides different levels of information for different levels of understanding of SPI/VMS and the VMS operating system.

32031 **Automated dimensional analysis using a light-sectioning microscope.** Loomis, J. (The Univ. of Dayton Research Institute, Dayton, OH (US)); Lightman, A.; Poe, A.; Caldwell, R. pp. 160 of Precision instrument design. Bristow, T.C.; Hatheway, A.E. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8811254–: Precision instrument design, Santa Clara, CA (USA), 1-3 Nov 1988).

A computyer vision system has been integrated with a modified light- sectioning microscope for the quality control and inspection of a machined part whose critical dimensions are in the range of 30 to 300 μm. Height measurements were determined by analysis of

the projected light-section line. Transverse measurements were made using the microscope in a traditional configuration with illumination from selected elements of an external LED ring array. The light section irradiance was under computer control to accommodate the spatial variations in surface reflectance whose dynamic range exceeded that of the vision system. part features are located by the vision system. Edges and line centers are then measured to sub-pixel resolution with a gray-level analysis algorithm. This paper describes the design and operation of this system. Details of the measurement process and analysis algorithms are provided.

32032 **One-way analysis of variance with unequal variances.** Rice, W.R. (Univ. of New Mexico, Albuquerque (USA)); Gaines, S.D. *Proceedings of the National Academy of Sciences of the United States of America (USA),* 86(21): 8183-8184 (Nov 1989).

The author have design a statistical test that eliminates the assumption of equal group variances from one-way analysis of variance. This test is preferable to the standard technique of trial-and-error transformation and can be shown to be an extension of the Behrens-Fisher T test to the case of three or more means. They suggest that this procedure be used in most applications where the one-way analysis of variance has traditionally been applied to biological data.

32033 **Multi-processor including data flow accelerator module.** Davidson, G.S.; Pierce, P.E. To Dept. of Energy, Washington, DC. USA Patent 4893234/A/. 9 Jan 1990. Filed date 15 Jan 1987. USA Patent Application 7-003,540. Int. Cl. G06F 13/00. vp.

This patent describes a data flow computer for implementing a data flow graph. The computer including a plurality of processing means, each operable for executing a primitive computation of a node of the graph, and accelerator means for accelerating execution of the computation. The accelerator means comprising: a plurality of memory cells for representing, respectively, each of the nodes of the graph, each memory cell including: a plurality of slot means for storing all the data operands required for a primitive computation; and indicating means for providing a first output upon conclusion of each memory cycle for indicating that all operands required by a primitive associated with the cell are available; and identifying means for storing the address of each memory cell with an indicating means providing a first output.

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Refer also to citation(s) 31313, 31660, 31675

32034 (EPRI-GS–6812) **Database for hydrocarbon-contaminated site remediation: Software and manual: Final report.** Spear, C.E.; Worm, G.H.; Rosebrook, D.D. Electric Power Research Inst., Palo Alto, CA (USA); Mill Creek Co., Houston, TX (USA). c Apr 1990. 50p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Report includes 5 diskettes designed to operate on an IBM PC or compatible equipment.

This document comprises both the final report for this project as well as the user's manual for the MGP Site Remediation Database. The database provides information about contractors working in environmental services. The data in the database were secured directly from each contractor by questionnaire. The database contains such information as EPA districts in which the organization works, qualifications, expertise, references, etc. The report describes the steps taken in constructing the database. 1 fig.

32035 (INDC(BZL)–032/L) **Nuclear Data Centre Bulletin No. 13.** Corcuera, R.P. (ed.) (Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados). International Atomic Energy Agency, Vienna (Austria). International Nuclear Data Committee. Feb 1990. 11p. Order Number DE90627117. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The document presents the structure of the Nuclear Data Centre of the Institute of Advanced Studies (Brazil) and a list of its technical and scientific publications in 1987.

Corporate Author Index

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217142/9/XAB	15:30982	NTIS, PC A01/MF A01			
217148/6/XAB	15:32003	NTIS, PC A02/MF A01			
217163/5/XAB	15:30983	NTIS, PC A03/MF A01			
217168/4/XAB	15:30923	NTIS, PC A03/MF A01			
217171/8/XAB	15:30984	NTIS, PC A01/MF A01			
217189/0/XAB	15:30839	NTIS, PC A23/MF A03			
217199/9/XAB	15:30934	NTIS, PC A03/MF A01			
217217/9/XAB	15:31586	NTIS, PC A02/MF A01			
217223/7/XAB	15:31704	NTIS, PC A01/MF A01			
217228/6/XAB	15:31342	NTIS, PC A05/MF A01			
217237/7/XAB	15:30618	NTIS, PC A02/MF A01			
217258/3/XAB	15:31459	NTIS, PC A03/MF A01			
217259/1/XAB	15:31460	NTIS, PC A03/MF A01			
217264/1/XAB	15:31587	NTIS, PC A04/MF A01			
217265/8/XAB	15:31335	NTIS, PC A03/MF A01			
217269/0/XAB	15:30637	NTIS, PC A04/MF A01			
217286/4/XAB	15:30638	NTIS, PC A05/MF A01			
217300/3/XAB	15:32004	NTIS, PC A03/MF A01			
217301/1/XAB	15:31677	NTIS, PC A02/MF A01			
217337/5/XAB	15:31033	NTIS, PC A04/MF A01			
217339/1/XAB	15:31333	NTIS, PC A03/MF A01			
217345/8/XAB	15:31588	NTIS, PC A03/MF A01			
217346/6/XAB	15:31589	NTIS, PC A03/MF A01			
217347/4/XAB	15:31590	NTIS, PC A04/MF A01			
217348/2/XAB	15:31336	NTIS, PC A04/MF A01			
217387/0/XAB	15:30641	NTIS, PC A02/MF A01			
217393/8/XAB	15:32005	NTIS, PC A05/MF A01			
217398/7/XAB	15:31701	NTIS, PC A05/MF A01			
217400/1/XAB	15:30985	NTIS, PC A08/MF A01			
217405/0/XAB	15:31343	NTIS, PC A05/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
217421/7/XAB	15:32006	NTIS, PC A01/MF A01			
217424/1/XAB	15:32007	NTIS, PC A02/MF A01			
217439/9/XAB	15:31344	NTIS, PC A05/MF A01			
217444/9/XAB	15:31345	NTIS, PC A05/MF A01			
217452/2/XAB	15:30589	NTIS, PC A03/MF A01			
217462/1/XAB	15:30575	NTIS, PC A03/MF A01			
217489/4/XAB	15:32008	NTIS, PC A03/MF A01			
217501/6/XAB	15:31334	NTIS, PC A03/MF A01			
217506/5/XAB	15:31265	NTIS, PC A08/MF A01			
217507/3/XAB	15:31266	NTIS, PC A10/MF A02			
217508/1/XAB	15:30737	NTIS, PC A01/MF A01			
217509/9/XAB	15:31461	NTIS, PC A99/MF E09			
217510/7/XAB	15:31705	NTIS, PC A04/MF A01			
217558/6/XAB	15:31702	NTIS, PC A03/MF A01			
217562/8/XAB	15:30986	NTIS, PC A01/MF A01			
217563/6/XAB	15:30987	NTIS, PC A01/MF A01			
217584/2/XAB	15:30988	NTIS, PC A02/MF A01			
217587/5/XAB	15:30989	NTIS, PC A01/MF A01			
217590/9/XAB	15:30990	NTIS, PC A02/MF A01			
217592/5/XAB	15:30991	NTIS, PC A01/MF A01			
217596/6/XAB	15:31267	NTIS, PC A06/MF A01			
217598/2/XAB	15:30992	NTIS, PC A02/MF A01			
217599/0/XAB	15:30993	NTIS, PC A01/MF A01			
217600/6/XAB	15:30994	NTIS, PC A03/MF A01			
217604/8/XAB	15:31034	NTIS, PC A03/MF A01			
217605/5/XAB	15:31926	NTIS, PC A03/MF A01			
217610/5/XAB	15:31337	NTIS, PC A08/MF A01			
217617/0/XAB	15:31338	NTIS, PC A04/MF A01			
217625/3/XAB	15:32009	NTIS, PC A02/MF A01			
217626/1/XAB	15:32010	NTIS, PC A02/MF A01			
217628/7/XAB	15:30642	NTIS, PC A01/MF A01			
217636/0/XAB	15:31462	NTIS, PC A06/MF A01			
217649/3/XAB	15:31570	NTIS, PC A06/MF A01			
217682/4/XAB	15:32011	NTIS, PC A03/MF A01			
AERE-G–					
4772	15:30198	*See* ETSU-B–7050			
AERE-R–					
13325	15:30111	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627024	
13448	15:31463	H.M. Stationery Office, London, price Pound 10.00			
13468	15:31472	*See* DOE-RW–89.065			
13660	15:30112	H.M. Stationery Office, London, price Pound 14.00			
13679	15:31346	HM Stationery Office, London, UK, price Pound 8.00			
13684	15:31347	HM Stationery Office, London, UK, price Pound 14.00			
AFIT/CI/CIA–					
88-199	15:31345	*See* AD-A–217444/9/XAB			
88-226	15:31570	*See* AD-A–217649/3/XAB			
89-031	15:31701	*See* AD-A–217398/7/XAB			
AFME–					
003	15:30576	NTIS (US Sales Only), PC A14/MF A01		DE90784641	
82.066.4	15:30577	NTIS (US Sales Only), PC A99/MF A01		DE90784627	
82.066.5	15:30451	NTIS (US Sales Only), PC A07/MF A01		DE90784623	
82.066.6	15:30446	NTIS (US Sales Only), PC A19/MF A01		DE90784625	
85.09.1134	15:30195	NTIS (US Sales Only), PC A05/MF A01		DE90784639	
85.91.1002.06	15:30446	*See* AFME–82.066.6			
85.91.1002.4	15:30577	*See* AFME–82.066.4			
85.91.1002.5	15:30451	*See* AFME–82.066.5			
AFME-FR–					
7	15:30506	NTIS (US Sales Only), PC A04/MF A01		DE90784621	
18	15:30452	NTIS (US Sales Only), PC A03/MF A01		DE90784629	
19	15:30516	NTIS (US Sales Only), PC A03/MF A01		DE90784631	
22	15:30590	NTIS (US Sales Only), PC A04/MF A01		DE90784633	
ANL–					
90/11	15:30884	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008242	PC-400; PC-500
ANL-HEP-CP–					
89-120	15:31757	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010545	MF-414

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ANL-HEP-CP–					
89-126	15:31779	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010546	MF-414
90-05	15:31067	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009712	MF-414
90-07	15:31805	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010583	MF-414
ANL/FPP/TM–					
246	15:31973	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010277	PC-420; PC-424
247	15:31927	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010302	PC-420
ANL/NDM–					
115	15:31832	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010753	MF-413
ANL/TM–					
475	15:32012	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008238	MF-405
ANU-PRL-PP–					
89/5	15:31974	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625559	
AOSTRA–					
90-02283	15:30458	PC Alberta Oil Sands Technology and Research Authority, 500 Highfield Pl., 10010-106 St., Edmonton, AB, CAN T5J 3L8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ARFSD-TR–					
89021	15:31033	*See* AD-A–217337/5/XAB			
ARI-RR–					
750	15:30589	*See* AD-A–217452/2/XAB			
ASIPP–					
006	15:31975	*See* CNIC–00276			
BC/P–					
90-01762	15:30071	PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
BCH–					
90-01218	15:30496	PC British Columbia Legislative Library, Government Documents Division, Parliament Buildings, Victoria, BC, CAN V8V 1X4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
BESSY-TB–					
140/89-COSY	15:31239	Berliner Elektronenspeicherring-Gesellschaft fuer Synchrotronstrahlung mbH (BESSY), Berlin (Germany, F.R.)			
BFI–					
1124	15:30578	Copy held by UB/TIB Hannover			
BIHEP–					
0010	15:31783	*See* CNIC–00270			
BIHEP-TH–					
0007	15:31782	*See* CNIC–00227			
BINE–					
0003	15:30101	*See* CNIC–00053			
BMVg-FBWM–					
90-5	15:31268	Bundesministerium der Verteidigung, Bonn (Germany, F.R.). Dokumentations- und Fachinformationszentrum der Bundeswehr (DOKFIZBw)			
BNL–					
43788	15:30044	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000233	PC-122
44436	15:30283	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010017	MF-402
44452	15:31758	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010121	MF-414
44470	15:31109	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010019	MF-413
44473	15:31110	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010123	MF-414
44516	15:31111	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010648	MF-414
44517	15:32013	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010649	MF-405
44520	15:31759	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010646	MF-414
52205-Add.	15:31554	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008241	PC-407

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BNL-NUREG–					
44385	15:30370	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010013	MF-400
BONN-IR–					
88-35	15:31269	NTIS (US Sales Only), PC A03/MF A01		DE90785076	
88-36	15:31780	NTIS (US Sales Only), PC A04/MF A01		DE90785080	
89-42	15:31781	NTIS (US Sales Only), PC A05/MF A01		DE90785078	
89-45	15:31122	NTIS (US Sales Only), PC A03/MF A01		DE90784925	
89-53	15:31270	NTIS (US Sales Only), PC A04/MF A01		DE90785077	
90-01	15:31271	NTIS (US Sales Only), PC A05/MF A01		DE90785079	
BONN-ME–					
90-01	15:31854	NTIS (US Sales Only), PC A03/MF A01		DE90784938	
BR–					
89(22)	15:31464	OSTI; US Fish and Wildlife Service, NASA-Slidell Computer Complex, 1010 Gause Boulevard, Slidell, LA 70458		TI90010605	
BRIUOP–					
0003	15:30114	*See* CNIC–00101			
0007	15:30887	*See* CNIC–00157			
0008	15:30890	*See* CNIC–00185			
BS–					
8502/1	15:31571	Copy held by UB/TIB Hannover			
BUGRI–					
0001	15:30889	*See* CNIC–00178			
BUMINES-IC–					
9233	15:30033	*See* PB–90-171554/XAB			
BUMINES-RI–					
9281	15:30093	*See* PB–90-171489/XAB			
9287	15:31668	*See* PB–90-171521/XAB			
CBPF-NF–					
027/89	15:31678	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625593	
034/89	15:31889	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625399	
CCME–					
TS/WM-TRE008-E	15:30459	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CE–					
02888	15:30598	*See* NBES–2014			
02912	15:30488	*See* YEDT–CE02912			
02913	15:30266	*See* YEDT–3766-4-8			
02914	15:30226	*See* YEDT–3766-4-6			
02915	15:30546	*See* YEDT–3766-4-3			
02916	15:30547	*See* YEDT–3766-4-9			
02917	15:30548	*See* YEDT–3766-4-16			
02919	15:30550	*See* YEDT–3766-4-27			
02920	15:30201	*See* YEDT–3766-4-20			
02921	15:30549	*See* YEDT–3766-4-22			
02923	15:30205	*See* QER-ERI–6460-13			
02924	15:30281	*See* SE–5845-01-1-79			
02925	15:30239	*See* PWC/SPO–CE02925			
02926	15:30280	*See* SE–5845-00-1-79			
02936	15:30539	*See* SEMR–FP34			
02937	15:30541	*See* SRC–FP16			
02941	15:30524	*See* IRTA–CE02941			
02942	15:30595	*See* CP/MJ–FP44			
02943	15:30279	*See* SASKOIL–FP7			
02944	15:30540	*See* SRC–FP15			
02945	15:30543	*See* SRC–FP19			
02946	15:30542	*See* SRC–FP18			
02947	15:30538	*See* SEMR–FP28			
02972	15:30597	*See* FSC–CE02972			
02973	15:30599	*See* NBES–2040			
02974	15:30220	*See* NBES–2064			
02976	15:30615	*See* NBES–2025			
02984	15:30240	*See* PWC/SPO–CE02984			
02986	15:30607	*See* EMR/OEC–CE02986			
02987	15:30242	*See* CSR–23380-1-6734			

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02993	15:30509	*See* PAI–CE02993			
02996	15:30976	*See* CICS–CE02996			
02997	15:30944	*See* CICS–CE02997			
02998	15:30216	*See* EMR–CE02998			
CEA-CONF–					
9950	15:30738	NTIS (US Sales Only), PC A02/MF A01		DE90784604	
9951	15:30739	NTIS (US Sales Only), PC A02/MF A01		DE90784603	
9952	15:31123	NTIS (US Sales Only), PC A03/MF A01		DE90784655	
9953	15:31890	NTIS (US Sales Only), PC A02/MF A01		DE90784605	
9954	15:30643	NTIS (US Sales Only), PC A03/MF A01		DE90773408	
9963	15:30740	NTIS (US Sales Only), PC A02/MF A01		DE90784602	
CEA-DAS–					
620	15:30109	NTIS (US Sales Only), PC A02/MF A01		DE90784658	
621	15:30174	NTIS (US Sales Only), PC A02/MF A01		DE90784653	
623	15:30110	NTIS (US Sales Only), PC A02/MF A01		DE90784657	
624	15:30175	NTIS (US Sales Only), PC A03/MF A01		DE90784656	
626	15:30324	NTIS (US Sales Only), PC A03/MF A01		DE90784665	
643	15:30956	NTIS (US Sales Only), PC A03/MF A01		DE90784664	
646	15:30957	NTIS (US Sales Only), PC A03/MF A01		DE90784666	
649	15:30351	NTIS (US Sales Only), PC A02/MF A01		DE90784667	
650	15:30352	NTIS (US Sales Only), PC A02/MF A01		DE90784663	
CEGB-RD/B–					
6237/R89	15:30356	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624998	
CEQ–					
90010530	15:31348	OSTI; GPO; Council on Environmental Quality, Executive Office of the President, Washington, DC		DE90010530	
CHA–					
89-05632	15:30222	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CICS–					
CE02996	15:30976	Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST			
CE02997	15:30944	Combustion Institute, Canadian Section, Dept. of Mechanical Engineering, Royal Military College, Kingston, ON, CAN K7K 5L0. Prices: PRICES UPON REQUEST			
CINIE–					
001	15:30346	*See* CNIC–00315			
CMHC–					
90-02259	15:30487	PC Canada Mortgage and Housing Corporation, Annex Bldg., 682 Montreal Rd., Ottawa, ON, CAN K1A 0P7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CN-RA–					
0063-REV-1	15:31265	*See* AD-A–217506/5/XAB			
0064-REV-1	15:31266	*See* AD-A–217507/3/XAB			
CNIC–					
00053	15:30101	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626206	
00092	15:30098	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626198	
00097	15:30113	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627012	
00101	15:30114	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627026	
00109	15:30886	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626019	
00157	15:30887	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626020	
00164	15:31928	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625429	

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00165	15:31272	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626914	
00166	15:30102	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626207	
00167	15:30115	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90627013	
00168	15:30103	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626208	
00172	15:30888	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626021	
00177	15:31929	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625444	
00178	15:30889	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626040	
00179	15:31565	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626546	
00180	15:31930	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625515	
00184	15:30927	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626150	
00185	15:30890	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626022	
00200	15:31566	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626528	
00205	15:31465	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626328	
00215	15:31349	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626335	
00218	15:30928	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626129	
00220	15:31350	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626336	
00222	15:31273	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626915	
00227	15:31782	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625610	
00229	15:30357	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626801	
00233	15:31572	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626498	
00235	15:30355	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626796	
00239	15:31679	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625601	
00242	15:31274	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626917	
00244	15:31124	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626760	
00246	15:31818	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625882	
00253	15:31275	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626950	
00254	15:31886	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626691	
00255	15:31931	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625430	
00256	15:31932	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625431	
00258	15:31420	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626294	
00259	15:31573	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626499	
00264	15:31574	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626347	
00270	15:31783	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625611	
00275	15:31575	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626500	
00276	15:31975	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626601	
00278	15:31276	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626918	

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00284	15:30178	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626735	
00286	15:31576	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90626348	
00315	15:30346	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627042	
CONF-8203222–		(Workshop on the lithosphere; Austin, TX (USA); 15-19 Mar 1982)			
Summ.	15:31644	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010445	MF-403
CONF-830001–		(34. Alaska science conference; Whitehorse (Canada);			
	15:30488	*See* YEDT–CE02912			
CONF-8510517–		(Renewable energy research and developement workshop; Montebello (Canada); 21-22 Oct 1985)			
	15:30509	*See* PAI–CE02993			
CONF-8602184–		(Board on Earth Sciences meeting; Washington, DC (USA); 7 Feb 1986)			
Summ.	15:31645	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010504	MF-403
CONF-8604259–		(21. winter school of physics; Zakopane (Poland); 7-11 Apr 1986)			
	15:31860	*See* INP–1344/PS			
CONF-8611306–		(Workshop in radioecology; Neuherberg (Germany, F.R.); 5-7 Nov 1986)			
	15:31427	*See* ISH–128			
CONF-861207–		(Materials Research Society fall meeting; Boston, MA (USA); 1-5 Dec 1986)			
	15:30684	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			
CONF-8702184–		(2. summit meeting of chief executives of solid-earth science organizations; Washington, DC (USA); 6 Feb 1987)			
Summ.	15:31646	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010503	MF-403
CONF-8705403–		(The Combustion Institute Canadian Section spring technical meeting; Vancouver (Canada); 28-29 May 1987)			
	15:30944	*See* CICS–CE02997			
CONF-8706413–		(Energiville colloquium; Sophia-Antipolis (France); 4-5 Jun 1987)			
	15:30576	*See* AFME–003			
CONF-8712165–		(2. workshop of German and Polish research on high temperature corrosion of metals; Juelich (Germany, F.R.); 2-4 Dec 1987)			
	15:30669	*See* Juel-Conf–76			
CONF-880403–		(American power conference; Chicago, IL (USA); 18-20 Apr 1988)			
	15:30428				
CONF-8806219–		(Advances in dynamic analysis of plates and shells; Pittsburgh, PA (USA); 19-23 Jun 1988)			
	15:30683	American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017 (USA)			
CONF-8806468–		(Symposium on marsh management in coastal Louisiana; Baton Rouge, LA (USA); 7-10 Jun 1988)			
	15:31464	*See* BR–89(22)			
CONF-8806469–		(The Combustion Institute Canadian Section spring technical meeting; Halifax (Canada); 1-3 Jun 1988)			
	15:30976	*See* CICS–CE02996			
CONF-880679–		(81. annual meeting of Air Pollution Control Association; Dallas, TX (USA); 19-24 Jun 1988)			
	15:29974	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:31413	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:31414	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
	15:31415	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:31416	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
CONF-880711–		(Canadian small hydro developers course and small hydro '88: international conference and trade show; Toronto (Canada); 4-9 Jul 1988)			
	15:30216	*See* EMR–CE02998			
CONF-8809221–		(International meeting on reduced enrichment for research and test reactors (RERTR); San Diego, CA (USA); 18-24 Sep 1988)			
8	15:30347	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010403	MF-520
CONF-8810399–		(4. international laser science conference; Atlanta, GA (USA); 2-6 Oct 1988)			
	15:30723				
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	15:31972				
CONF-890145–		(SPIE conference on optics, electro-optics and laser applications in science and engineering: OE/LASE '89; Los Angeles, CA (USA); 15-20 Jan 1989)			
27	15:31005	*See* UCRL–99297			
CONF-890203–		(IAEA international symposium on fire protection and fire fighting at nuclear installations; Vienna (Austria); 27 Feb - 3 mar 1989)			
	15:30956	*See* CEA-DAS–643			
	15:30957	*See* CEA-DAS–646			
CONF-890421–		(91. annual meeting of the American Ceramic Society; Indianapolis, IN (USA); 23-27 Apr 1989)			
13	15:30741	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010544	MF-404
14	15:30742	NTIS, PC A03/MF A01 - OSTI		DE90010543	MF-404
CONF-8904308–		(Workshop on multi-dimensional hyperbolic problems and computations; Minneapolis, MN (USA); 3-14 Apr 1989)			
2	15:31916	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010069	MF-405
CONF-8905144–		(Tau-Charm Factory workshop; Stanford, CA (USA); 23-27 May 1989)			
16	15:31784	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010722	MF-414
CONF-8905310–		(93. casting congress of the American Foundryman's Society; San Antonio, TX (USA); 9-11 May 1989)			
1	15:30663	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010461	MF-313

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890549–		(21. offshore technology conference and exhibition (OTC-21); Houston, TX (USA); 1-4 May 1989)			
	15:30980	*See* GKSS–89/E/30			
CONF-8906137–		(Joint NEA/CEC workshop on technical aspects of emergency planning; Brussels (Belgium); 27-29 Jun 1989)			
	15:30324	*See* CEA-DAS–626			
CONF-890631–		(International symposium on packaging and transportation of radioactive materials; Washington, DC (USA); 11-16 Jun 1989)			
	15:30109	*See* CEA-DAS–620			
	15:30110	*See* CEA-DAS–623			
	15:30174	*See* CEA-DAS–621			
	15:30175	*See* CEA-DAS–624			
69	15:30960	*See* EGG-M–88360			
CONF-8906317–		(Workshop on differential equations and applications; Retzhof (Austria); 18-24 Jun 1989)			
1	15:32015	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010419	MF-405
CONF-8906318–		(11. EPRI radwaste workshop; Boulder, CO (USA); 26-28 Jun 1989)			
	15:30122	*See* EPRI-NP–6808			
CONF-890673–		(IWGFR specialists meeting on advanced controls for fast reactors; Argonne, IL (USA); 20-22 Jun 1989)			
	15:30356	*See* CEGB-RD/B–6237/R89			
CONF-890703–		(International conference on ion sources; Berkeley, CA (USA); 10-14 Jul 1989)			
	15:31105				
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	15:31992				
	15:31993				
CONF-8907118–		(25. ASME/AIAA joint propulsion conference; Monterey, CA (USA); 10-13 Jul 1989)			
2	15:30588	*See* UCRL–99623			
CONF-8907130–		(9. international conference on vacuum ultraviolet radiation physics; Honolulu, HI (USA); 17-21 Jul 1989)			
	15:31239	*See* BESSY-TB–140/89-COSY			
CONF-8907134–		(17. SLAC summer institute: physics at the 100 GeV mass scale; Stanford, CA (USA); 10-21 Jul 1989)			
9	15:31792	*See* SLAC-PUB–5210			
CONF-890718–		(International conference on materials and mechanisms of superconductivity - high-temperature superconductors II; Stanford, CA (USA); 23-28 Jul 1989)			
	15:30740	*See* CEA-CONF–9963			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8907169–		(NATO conference on dynamical localization; Lyngby (Denmark); 26 Jul 1989)			
1	15:31895	*See* LA-UR–90-1354			
CONF-8907190–		(1. international workshop on accelerator alignment; Stanford, CA (USA); 31 Jul - 2 aug 1989)			
1	15:31791	*See* SLAC-PUB–5204			
CONF-890723–		(26. annual conference on nuclear and space radiation effects; Marco Island, FL (USA); 25-29 Jul 1989)			
	15:31299				
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	15:31311				
CONF-890802–		(7. synchrotron radiation instrumentation (SRI) national conference; Berkeley, CA (USA); 6-10 Aug 1989)			
27	15:31125	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010460	MF-414; MF-404
CONF-8908131–		(2. LAMPF workshop on pion-nucleus double charge exchange; Los Alamos, NM (USA); 9-11 Aug 1989)			
5	15:31856	*See* DOE/ER/40427–28-N9			
6	15:31876	*See* LA-UR–90-1360			
CONF-890814–		(American Institute of Chemical Engineer's summer national meeting; Philadelphia, PA (USA); 20-23 Aug 1989)			
10	15:29995	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010491	MF-602
CONF-8908143–		(8. international conference on hyperfine interactions; Prague (Czechoslovakia); 14-19 Aug 1989)			
	15:30738	*See* CEA-CONF–9950			
	15:30739	*See* CEA-CONF–9951			
CONF-8908145–		(4. workshop on RF superconductivity; Ibaraki-Ken (Japan); 14-18 Aug 1989)			
	15:31123	*See* CEA-CONF–9952			
CONF-8908178–		(Gregynog international conference on nonlinear diffusion equations and their equilibrium states; Newton (UK); 20-29 Aug 1989)			
2	15:31934	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010065	MF-420; MF-405
CONF-890821–		(13. international conference on atomic collisions in solids; Aarhus (Denmark); 7-11 Aug 1989)			
	15:30643	*See* CEA-CONF–9954			
CONF-8908222–		(3. international conference on laser interferometry; San Diego, CA (USA); 6-11 Aug 1989)			
2	15:31312	*See* EGG-M–89048			
CONF-8908226–		(12. International Congress on X-ray Optics and Microanalysis; Cracow (Poland); 28 Aug - 1 sep 1989)			
	15:31890	*See* CEA-CONF–9953			
CONF-890855–		(10. international conference on Structural Mechanics in Reactor Technology (SMIRT); Anaheim, CA (USA); 14-18 Aug 1989)			
	15:30351	*See* CEA-DAS–649			
	15:30352	*See* CEA-DAS–650			
CONF-890861–		(13. biennial international conference on amorphous and liquid semiconductors (ICALS-13) and the first international conference on amorphous semiconductor technology (ICAST-1); Asheville, NC (USA); 21-26 Aug 1989)			
4	15:30248	*See* MBB-Z–0251-89-PUB			

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CONF-8909141–		(12. international meeting on reduced enrichment for research and test reactors; Berlin (Germany, F.R.); 10-13 Sep 1989)			
10	15:30100	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010418	MF-525
CONF-8909249–		(Lattice '89: symposium on lattice field theory; Capri (Italy); 18-21 Sep 1989)			
12	15:31779	*See* ANL-HEP-CP–89-126			
CONF-8909268–		(IAEA consultants' meeting on activation cross sections for the generation of long-lived radionuclides of importance in fusion reactor technology; Argonne, IL (USA); 11-14 Sep 1989)			
	15:31820	*See* INDC(NDS)–232/L			
CONF-8909291–		(8. topical workshop on proton-antiproton collider physics; Castiglione della Pescaia (Italy); 1-5 Sep 1989)			
7	15:31763	*See* FNAL/C–90/32-E			
8	15:31764	*See* FNAL/C–90/33-E			
9	15:31786	*See* FNAL/C–90/34-E			
CONF-8909305–		(Workshop on high field NMR and biological applications; Richland, WA (USA); 8-9 Sep 1989)			
	15:31547	*See* PNL-SA–18016			
CONF-890979–		(Fundamental symmetries in nuclei and particles; Pasadena, CA (USA); 7-9 Sep 1989)			
3	15:31857	*See* DOE/ER/40427–31-N9			
CONF-8910120–		(1. international ceramic science and technology congress; Anaheim, CA (USA); 31 Oct - 3 nov 1989)			
10	15:30998	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009721	MF-201
CONF-8910121–		(6. topical conference on physics with polarized beams on polarized targets; Spencer, IN (USA); 16-18 Oct 1989)			
4	15:31757	*See* ANL-HEP-CP–89-120			
5	15:31126	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010578	MF-414; MF-413
CONF-891013–		(6. symposium on separation science and technology for energy applications; Knoxville, TN (USA); 22-27 Oct 1989)			
10	15:30104	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010416	MF-526
CONF-8910183–		(11. annual conference and exposition on Appalachian coal: the clean fuel choice for today's needs and tomorrow's growth; Roanoke, VA (USA); 2-4 Oct 1989)			
	15:29996	*See* DOE/MC/26387–2810			
CONF-8910289–		(Western States Section meeting of the Combustion Institute; Livermore, CA (USA); 23-24 Oct 1989)			
6	15:30979	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010032	MF-406
CONF-8910325–		(9. Oak Ridge National Laboratory life sciences symposium; Knoxville, TN (USA); 24-27 Oct 1989)			
1	15:30231	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010540	MF-902
CONF-8910357–		(Impedance and bunch instability workshop; Argonne, IL (USA); 31 Oct - 1 nov 1989)			
2	15:31071	*See* SLAC-PUB–5177			
CONF-8910395–		(Illinois energy conference; Chicago, IL (USA); 20 Oct 1989)			
1	15:30517	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010413	MF-350
CONF-8910396–		(Conference on lasers in science and technology; Amman (Jordan); 21-27 Oct 1989)			
1	15:31706	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010462	MF-411
CONF-8910400–		(Workshop on large-scale numerical optimization; Ithaca, NY (USA); 19-20 Oct 1989)			
1	15:32016	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010084	MF-405
2	15:32017	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009702	MF-405
CONF-8910401–		(1. Great Lakes computer science conference; Kalamazoo, MI (USA); 18-20 Oct 1989)			
1	15:32018	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010114	MF-405

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CONF-891043–		(SNEAP '89: symposium of northeastern accelerator personnel; Oak Ridge, TN (USA); 22-27 Oct 1989)			
4	15:31043	*See* DOE/ER/40048–235-LO			
CONF-891044–		(1. international conference on radioactive nuclear beams; Berkeley, CA (USA); 16-18 Oct 1989)			
10	15:31838	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009720	MF-413
CONF-891055–		(5. international symposium on the production and neutralization of negative ions and beams; Upton, NY (USA); 30 Oct - 3 nov 1989)			
16	15:31110	*See* BNL–44473			
CONF-891093–		(36. American Vacuum Society national vacuum symposium; Boston, MA (USA); 23-27 Oct 1989)			
28	15:30743	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010092	MF-404; MF-364
29	15:30744	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010538	MF-401; MF-411
CONF-8911158–		(Workshop to design an acid deposition policy model for Southeast Asia; Bangkok (Thailand); 13-17 Nov 1989)			
2	15:31351	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010459	MF-602
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
123	15:30745	NTIS, PC A02/MF A01; OSTI; INIS		DE90010071	MF-401; MF-411
124	15:30840	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010073	MF-404
125	15:30746	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010457	MF-404
126	15:30995	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010458	MF-221
127	15:30747	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010412	MF-364
128	15:30748	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010404	MF-364
129	15:30644	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010409	MF-404
130	15:30645	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010537	MF-404; MF-401
131	15:30749	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009724	MF-404; MF-401
CONF-891185–		(Asia-Pacific coal technology conference; Honolulu, HI (USA); 14-16 Nov 1989)			
1	15:30016	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010406	MF-101
CONF-891204–		(4. international conference on fusion reactor materials; Kyoto (Japan); 4-8 Dec 1989)			
30	15:31976	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010472	MF-423
31	15:31977	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010407	MF-420
32	15:31978	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009716	MF-423
CONF-891206–		(International chemical congress of Pacific Basin Societies (PACIFICHEM '89); Honolulu, HI (USA); 17-22 Dec 1989)			
11	15:30750	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010152	MF-401; MF-404
12	15:30909	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010541	MF-401
CONF-891208–		(Winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (USA); 10-15 Dec 1989)			
31	15:30371	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010408	MF-540
32	15:30996	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009725	MF-221
CONF-891210–		(9. Miami international congress on energy and environment; Miami Beach, FL (USA); 11-13 Dec 1989)			
3	15:31466	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010420	MF-403
CONF-891273–		(4. SIAM conference on parallel processing for scientific computing; Chicago, IL (USA); 11-13 Dec 1989)			
4	15:32014	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010066	MF-405
5	15:32028	*See* UCRL-JC–103580			
CONF-891286–		(International Atomic Energy Agency International Working Group on Fast Reactors; Kalpakkam (India); 12-15 Dec 1989)			
1	15:30358	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010474	MF-535; MF-541

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CONF-891287–		(U.S.-India workshop on environmental risk; New Delhi (India); 12-16 Dec 1989)			
1	15:30592	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010473	MF-630
CONF-900107–		(4. Berkeley international conference on erosion-corrosion-wear of materials at elevated temperatures; Berkeley, CA (USA); 31 Jan - 2 feb 1990)			
3	15:30018	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010113	MF-114
4	15:30646	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010141	MF-114
CONF-900117–		(14. annual conference on energy from biomass and wastes; Lake Buena Vista, FL (USA); 29 Jan - 2 feb 1990)			
2	15:30207	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010147	MF-242
CONF-900121–		(Transportation Research Board meeting; Washington, DC (USA); Jan 1990)			
6	15:30460	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010151	MF-121
CONF-900133–		(International conference on superconductivity; Bangalore (India); 10-14 Jan 1990)			
2	15:30997	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010415	MF-201
CONF-900135–		(General meeting of the Division of Particles and Fields of the American Physical Society; Houston, TX (USA); 3-6 Jan 1990)			
2	15:31810	*See* LA-UR–90-1390			
3	15:31815	*See* SLAC-PUB–5229			
4	15:31805	*See* ANL-HEP-CP–90-07			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
22	15:31891	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010492	MF-401; MF-411
23	15:31000	*See* LA-UR–90-1125			
CONF-900163–		(Accelerator computer code meeting; Los Alamos, NM (USA); 22-25 Jan 1990)			
7	15:31068	*See* LA-UR–90-1247			
8	15:31067	*See* ANL-HEP-CP–90-05			
CONF-900169–		(ICH design workshop; Boulder, CO (USA); 31 Jan - 2 feb 1990)			
2	15:31980	*See* DOE/ER/53263–8			
CONF-900179–		(Los Alamos National Laboratory (LANL) workshop on n-p Bremsstrahlung; Los Alamos, NM (USA); 25-26 Jan 1990)			
2	15:31766	*See* LA-UR–90-1242			
CONF-900183–		(Recontres De Moriond '90: new and exotic phenomena; Les Arcs (France); 20-27 Jan 1990)			
4	15:31922	*See* UCRL-JC–103562			
CONF-900188–		(3. international congress of fluid mechanics; Cairo (Egypt); 2-4 Jan 1990)			
1	15:31746	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010475	
CONF-900189–		(1989/90 conference on cloud impacts on DOD operations and systems; Monterey, CA (USA); Jan 1990)			
1	15:31894	*See* LA-UR–90-1275			
CONF-900206–		(119. TMS (The Minerals, Metals & Metallurgical Society) annual meeting and exhibit; Anaheim, CA (USA); 18-22 Feb 1990)			
7	15:30751	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010072	MF-404
8	15:30752	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010067	MF-404; MF-201
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
46	15:30163	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010082	MF-511
47	15:31421	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010622	MF-511
CONF-9002100–		(International Group on Research Reactors conference; Knoxville, TN (USA); 28 Feb - 2 mar 1990)			
2	15:31109	*See* BNL–44470			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9002116–		(Conference on fermentation technologies; Palmerston North (New Zealand); 12-15 Feb 1990)			
1	15:30594	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010414	MF-310
CONF-9002117–		(Workshop on parity violation in electron scattering; Pasadena, CA (USA); 22-24 Feb 1990)			
1	15:31785	*See* DOE/ER/40427–04-N90			
CONF-9002118–		(1990 Lake Louise winter institute: the standards model and beyond; Lake Louise (Canada); 18-24 Feb 1990)			
1	15:31769	*See* SLAC-PUB–5202			
CONF-900218–		(3. international conference on ceramic powder processing science; San Diego, CA (USA); 4-7 Feb 1990)			
2	15:30753	NTIS, PC A02/MF A01 - OSTI		DE90010142	
CONF-900254–		(14. symposium on explosives and pyrotechnics; Burlingame, CA (USA); 13-15 Feb 1990)			
3	15:31331	*See* UCRL–102581			
CONF-900275–		(5. international symposium on acoustic remote sensing of the atmosphere and oceans; New Delhi (India); 6-9 Feb 1990)			
2	15:31467	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010086	MF-402
CONF-900287–		(TMS symposium on high temperature superconducting compounds; Anaheim, CA (USA); 20-21 Feb 1990)			
2	15:30754	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010455	MF-213
CONF-9003100–		(International workshop on cold neutron sources; Los Alamos, NM (USA); 5-8 Mar 1990)			
4	15:31128	*See* LA-UR–90-1142			
CONF-9003102–		(12. U.S. TRIGA users conference; Austin, TX (USA); 11-14 Mar 1990)			
2	15:30959	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010068	MF-505; MF-520
CONF-9003147–		(13. international landfill gas symposium; Lincolnshire, IL (USA); 27-29 Mar 1990)			
1	15:30606	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010102	MF-321
CONF-9003149–		(3. test technology symposium; Laurel, MD (USA); 19-21 Mar 1990)			
1	15:31326	*See* LA-UR–90-1433			
2	15:31313	*See* LA-UR–90-1434			
CONF-900315–		(Solar '90: 19th American Solar Energy Society annual conference; Austin, TX (USA); 18-20 Mar 1990)			
3	15:30269	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010094	MF-234
CONF-9003150–		(5. international conference on instrumentation for colliding beam physics; Novosibirsk (USSR); 15-21 Mar 1990)			
1	15:31292	*See* SLAC-PUB–5207			
2	15:31130	*See* SLAC-PUB–5205			
CONF-9003151–		(Workshop on the interpretation of modern synthesis observations of spiral galaxies; Albuquerque, NM (USA); 11-15 Mar 1990)			
1	15:31682	*See* LA-UR–90-1123			
CONF-9003152–		(Strings '90: superstring workshop; College Station, TX (USA); 12-17 Mar 1990)			
1	15:31909	*See* FNAL/C–90/72-T			
CONF-9003154–		(Workshop on atomic physics at the advanced photon source; Argonne, IL (USA); 23-30 Mar 1990)			
1	15:31707	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010711	MF-411
CONF-900331–		(Workshop on heavy ion physics at the alternating gradient synchrotron; Upton, NY (USA); 3-7 Mar 1990)			
4	15:31758	*See* BNL–44452			
6	15:31759	*See* BNL–44520			
CONF-900348–		(2. international industrial symposium on the super collider; Miami, FL (USA); 14-16 Mar 1990)			
2	15:31127	*See* FNAL-TM–1654			
4	15:31111	*See* BNL–44516			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900351–		(3. annual presentation: HazMat Central; Rosemont, IL (USA); 13-15 Mar 1990)			
3	15:31641	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010085	
CONF-900377–		(Energy and the environment in the 21st century; Cambridge, MA (USA); 26-28 Mar 1990)			
4	15:30331	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010089	MF-530
CONF-900381–		(Heat engines and gas stream cleanup contractors review; Morgantown, WV (USA); 26-28 Mar 1990)			
1	15:30298	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008855	MF-103
CONF-900391–		(1990 American Institute of Chemical Engineers (AIChE) spring health and safety symposium; Orlando, FL (USA); 18-22 Mar 1990)			
6	15:30370	*See* BNL-NUREG–44385			
CONF-900402–		(199. national meeting of the American Chemical Society; Boston, MA (USA); 22-27 Apr 1990)			
6	15:29967	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009710	MF-401
CONF-900403–		(NACE Corrosion '90; Las Vegas, NV (USA); 23-27 Apr 1990)			
10	15:30156	*See* UCRL–102285			
CONF-9004110–		(4. national conference on microcomputer applications in energy; Tucson, AZ (USA); 25-27 Apr 1990)			
1	15:30282	*See* SERI/TP–257-3737			
CONF-9004133–		(American power conference; Chicago, IL (USA); 23-25 Apr 1990)			
1	15:30285	*See* DOE/ET/10815–142			
2	15:30372	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010137	MF-500
CONF-9004138–		(3. Canadian Nuclear Society international conference on simulation methods in nuclear engineering; Montreal (Canada); 18-20 Apr 1990)			
4	15:30373	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010581	MF-520
5	15:30349	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009714	MF-505; MF-506
CONF-9004146–		(16. DOE compatibility, aging and service life conference; Livermore, CA (USA); 24-26 Apr 1990)			
8	15:31314	*See* MLM–3633(OP)			
CONF-9004159–		(5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990)			
4	15:32019	NTIS, PC A02/MF A01 - OSTI		DE90010494	MF-405
5	15:31951	*See* UCRL–102438			
6	15:32024	*See* SAND–89-2930C			
CONF-900418–		(International conference on the physics of reactors: operation, design and computation; Marseilles (France); 23-26 Apr 1990)			
9	15:30368	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010096	MF-520
10	15:30332	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010070	MF-520
11	15:30366	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010547	MF-532
12	15:30333	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009711	MF-530
13	15:30105	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009715	MF-526
14	15:30334	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009717	MF-530
CONF-9004180–		(9. symposium on turbulence and diffusion; Roskilde (Denmark); 30 Apr - 3 may 1990)			
1	15:31411	*See* UCRL-JC–103279			
CONF-9004181–		(DOE Remedial Action Program conference; Albuquerque, NM (USA); 16-19 Apr 1990)			
1	15:30164	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010061	MF-511
CONF-9004184–		(25. Yamada conference on magnetic phase transitions; Osaka (Japan); 13-16 Apr 1990)			
1	15:30762	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010083	MF-404
CONF-9004185–		(4. national undergraduate resesearch conference; Schenectady, NY (USA); 19-21 Apr 1990)			
1	15:30133	*See* LA-UR–90-1251			
CONF-9004189–		(2. international conference for expert systems in numerical analysis; West Lafayette, IN (USA); 24 Apr 1990)			
1	15:32027	*See* UCRL-JC–103441			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
5	15:30647	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010090	MF-365
CONF-900424–		(Conference on the science and technology of thin film superconductors; Denver, CO (USA); 30 Apr - 4 may 1990)			
1	15:31908	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010707	MF-410; MF-201
CONF-900432–		(Science and technology of thin-film superconductors conference; Golden, CO (USA); 30 Apr - 4 may 1990)			
Absts.	15:31004	*See* SERI/TP–210-3723			
CONF-900439–		(35. international symposium and exhibition of the Society for the Advancement of Material and Process Engineers: advanced materials, the challenge for the next decade; Anaheim, CA (USA); 2-5 Apr 1990)			
1	15:30850	*See* MLM–3616(OP)			
CONF-900455–		(20. annual international symposium on electronic structures of solids; Gaussig (German Democratic Republic); 16-20 Apr 1990)			
1	15:31714	*See* UCRL-JC–103520			
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
9	15:30769	*See* SAND–89-3131C			
11	15:30648	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010143	MF-404
12	15:30649	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010053	MF-404
13	15:30755	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010054	MF-404
14	15:30756	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010139	MF-404
16	15:30757	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010124	MF-404
17	15:30650	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010145	MF-404; MF-365
18	15:30857	*See* UCRL-JC–103522			
19	15:30856	*See* UCRL-JC–103521			
20	15:30651	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010471	MF-404
21	15:30671	*See* LA-UR–90-1439			
22	15:30848	*See* LA-UR–90-1368			
23	15:30849	*See* LA-UR–90-1373			
24	15:30847	*See* LA-UR–90-1310			
25	15:30771	*See* UCRL-JC–103614			
26	15:30682	*See* UCRL-JC–103610			
27	15:30681	*See* UCRL-JC–103609			
28	15:30758	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010709	MF-404
29	15:30768	*See* SAND–89-2804C			
30	15:30759	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010712	MF-401; MF-404
31	15:31899	*See* UCRL-JC–103629			
CONF-900489–		(5. international conference on muon spin rotation, relaxation and resonance; Oxford (UK); 9-12 Apr 1990)			
1	15:30764	*See* LA-UR–90-1313			
CONF-900491–		(5. international conference on accelerator mass spectroscopy; Paris (France); 23-27 Apr 1990)			
1	15:30134	*See* LA-UR–90-1461			
CONF-9005123–		(9. annual international symposium on the incineration of radioactive, hazardous, mixed and medical wastes: incineration conference '90; San Diego, CA (USA); 14-18 May 1990)			
1	15:31318	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009709	MF-401
CONF-900513–		(Conference on the tribology of composite materials; Oak Ridge, TN (USA); 1-3 May 1990)			
1	15:30841	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009713	MF-404
CONF-9005135–		(1990 American control conference; San Diego, CA (USA); 23-25 May 1990)			
3	15:30963	*See* SAND–89-1997C			
4	15:32013	*See* BNL–44517			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9005164–		(IMOG measurement technology subgroup meeting; Largo, FL (USA); May 1990)			
1	15:30965	*See* SAND–90-1009C			
CONF-9005166–		(Conference on scanning microscopy; Bethesda, MD (USA); 5-10 May 1990)			
1	15:31662	*See* LA-UR–90-1196			
2	15:31663	*See* LA-UR–90-1197			
3	15:31664	*See* LA-UR–90-1198			
CONF-9005167–		(North American INGRES Users Association (NAIUA) conference; Salt Lake City, UT (USA); 6-10 May 1990)			
4	15:31997	*See* SAND–89-2727C			
CONF-900527–		(ICMC '90 topical symposium on high temperature superconductors: materials aspects; Garmisch-Partenkirchen (Germany, F.R.); 9-11 May 1990)			
1	15:30760	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009708	MF-404
2	15:31910	*See* LA-UR–90-1402			
CONF-900531–		(1. international symposium on the biological processing of coal; Orlando, FL (USA); 1-3 May 1990)			
1	15:29942	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010432	MF-108
CONF-900534–		(18. NATO/CCMS international technical meeting on air pollution modelling and its applications; Vancouver (Canada); 13-17 May 1990)			
2	15:31412	*See* UCRL-JC–103587			
CONF-900557–		(8. topical conference on high-temperature plasma diagnostics; Hyannis, MA (USA); 6-10 May 1990)			
2	15:31945	*See* LA-UR–90-1366			
3	15:31986	*See* SAND–90-0552C			
4	15:31987	*See* SAND–90-0631C			
CONF-900559–		(IEEE robotics and automation conference; Cincinnati, OH (USA); 13-18 May 1990)			
14	15:30958	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010405	MF-405
CONF-900562–		(Spring meeting of the Electrochemical Society; Montreal (Canada); 6-11 May 1990)			
3	15:30854	*See* SAND–90-0256C			
4	15:30631	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009707	MF-210
CONF-900563–		(7. symposium on radiation measurements and applications; Ann Arbor, MI (USA); 21-24 May 1990)			
2	15:31277	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010436	MF-406
3	15:30170	*See* LA-UR–90-1303			
CONF-900588–		(45. annual meeting of the Society of Tribologists and Lubrication Engineers; Denver, CO (USA); 7-10 May 1990)			
	15:30851	*See* N–90-12659			
CONF-900602–		(17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990)			
7	15:31939	*See* GA-A–20077			
8	15:31933	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010150	MF-420
9	15:31953	*See* UCRL-JC–102929			
CONF-900608–		(American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990)			
15	15:30319	*See* DOE/ER/40475–2			
16	15:31850	*See* DOE/ER/40475–3			
CONF-9006124–		(Society for Experimental Mechanics conference; Albuquerque, NM (USA); 4-6 Jun 1990)			
4	15:30961	*See* KCP–613-4232			
CONF-900613–		(International conference on fast reactor core and fuel structural behavior; Inverness (UK); 4-6 Jun 1990)			
2	15:30335	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009701	MF-530
CONF-9006163–		(Elliot symposium – ISS-AIME; Boston, MA (USA); 10-13 Jun 1990)			
1	15:30596	*See* EGG-M–90055			
CONF-9006169–		(7. international conference on logic programming; Jerusalem (Israel); 18-21 Jun 1990)			
1	15:32020	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010060	MF-405

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900617–		(Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990)			
10	15:30336	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010116	MF-538
11	15:30318	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010093	
CONF-9006170–		(15. international ARA congress; Montreal (Canada); 14-18 Jun 1990)			
1	15:30106	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010097	MF-401
CONF-9006172–		(Solid state and sensor actuator workshop; Hilton Head Island, SC (USA); 4-7 Jun 1990)			
1	15:31321	*See* SAND–90-0139C			
CONF-900619–		(5. AIAA/ASME thermal physics and heat transfer conference; Seattle, WA (USA); 18-20 Jun 1990)			
4	15:30970	*See* LA-UR–90-1374			
CONF-900623–		(15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990)			
4	15:30761	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010100	MF-404
5	15:30652	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010718	MF-404
6	15:30337	*See* WHC-SA–0757			
CONF-900774–		(International Institute of Welding conference; Montreal (Canada); 23-24 Jul 1990)			
2	15:30770	*See* SAND–90-0966C			
CP/MJ–					
FP44	15:30595	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
CPS–					
EPS7/AP/21	15:31352	PC Canada Conservation and Protection, Environmental Protection Publications, Place Vincent Massey, 10 Wellington St, 12th Floor, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CRC–					
567	15:30575	*See* AD-A–217462/1/XAB			
CRDEC-SP–					
017-VOL-1	15:31342	*See* AD-A–217228/6/XAB			
CRPC–					
90-01995	15:30074	PC Calgary Regional Planning Commission, Library, 4303-11 St. SE, Calgary, AB, CAN T2G 4X1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
CSR–					
23380-1-6734	15:30242	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
CTA-IEAv-NT–					
016/81	15:30179	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626686	
CTA-IEAv-RP–					
05/85	15:31806	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625288	
CTH-IEFT-PP–					
1989-06	15:31935	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625532	
1989-07	15:31936	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625533	
1989-10	15:31937	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625534	
CTH-RF–					
67	15:31881	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625701	
CTN–					
90-009	15:31329	*See* UCRL-ID–103173			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
90-010	15:31328	*See* UCRL-ID–103172			
CU-CS–					
449-89	15:32001	*See* AD-A–217093/4/XAB			
454-89	15:31998	*See* AD-A–217062/9/XAB			
CWI-AM-R–					
8905	15:31557	*See* PB–90-174012/XAB			
CWI-CS-R–					
8835	15:32022	*See* PB–90-173667/XAB			
CWS/SF–					
67E	15:31591	PC Canadian Wildlife Service, 175 Woodward Dr., Ottawa, ON, CAN K1A 0E7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
67F	15:31592	PC Canadian Wildlife Service, 175 Woodward Dr., Ottawa, ON, CAN K1A 0E7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
DESY-F21–					
90-01	15:31278	NTIS (US Sales Only), PC A07/MF A01		DE90784945	
DESY-F31–					
89-04	15:31760	Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)			
DLR-FB–					
89-51	15:30267	Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany, F.R.)			
DOD-D–					
5030.14	15:30481	*See* PB–90-139668/XAB			
5100.52	15:30483	*See* PB–90-139825/XAB			
5210.63	15:30419	*See* PB–90-175449/XAB			
5230.16	15:30484	*See* PB–90-179425/XAB			
DOD-I–					
5015.3	15:30482	*See* PB–90-139684/XAB			
DOE-RW–					
89.065	15:31472	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626329	
DOE/BC–					
89/3	15:30045	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000206	PC-122
90/3/SP	15:30046	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000220	PC-122; PC-125
DOE/BC/14000–					
2	15:30047	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000232	PC-122
DOE/BC/14125–					
21	15:30048	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000237	PC-122
DOE/BC/14246–					
3	15:30049	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010104	MF-122
4	15:30050	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010105	MF-122
DOE/BC/14403–					
T2	15:30038	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009998	MF-122
DOE/BC/14445–					
1	15:30051	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010133	MF-122
DOE/CE/15256–					
1	15:30519	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010006	MF-350
DOE/CE/15397–					
T5	15:30072	NTIS, PC A03/MF A01 - OSTI		DE90010048	MF-310
DOE/CE/15401–					
T7	15:31319	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009938	MF-310
DOE/CH/00016–					
2728	15:29943	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011673	PC-109
DOE/CH/10093–					
61	15:30243	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009476	MF-234
67	15:30259	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009482	MF-262
69	15:30186	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009484	MF-241
DOE/CH/10378–					
5	15:30116	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009899	MF-800
DOE/DP–					
0078T	15:31979	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008221	MF-712

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/EIA–					
0035(90/01)	15:30490	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010030	MF-950
0109(90/02)	15:30056	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90009750	MF-950
0125(89/4Q)	15:30017	NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010623	MF-950
0130(90/02)	15:30078	NTIS, PC A07/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010517	MF-950
0202(90/2Q)	15:30491	NTIS, PC A04/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010699	MF-950
0214(88)	15:30507	NTIS, PC A20/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010700	MF-950
0226(90/01)	15:30497	NTIS, PC A08/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010516	MF-950
0380(90/01)	15:30057	NTIS, PC A09/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010501	MF-950
0520(90/04)	15:30058	NTIS, PC A03/MF A01 - GPO - OSTI; GPO Dep.	E 1.99:	DE90010119	MF-950
DOE/ER–					
0443	15:30244	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008222	MF-400
0446P	15:31544	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010171	MF-408
0452P	15:31545	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008240	MF-408
DOE/ER/01545–					
438	15:31807	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009730	MF-414
440	15:31808	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009731	MF-414
DOE/ER/12018–					
T1	15:31647	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010442	MF-403
T10	15:31651	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010452	MF-403
T13	15:31469	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010505	MF-403
T14	15:31652	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010506	MF-403
T15	15:31653	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010507	MF-403
T16	15:31654	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010508	MF-403
T17	15:31655	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010509	MF-403
T18	15:31470	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010510	MF-403
T19	15:31656	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010511	MF-403
T2	15:30052	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010443	MF-403
T20	15:31657	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010512	MF-403
T21	15:31658	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010513	MF-403
T22	15:31659	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010514	MF-403
T23	15:31660	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010515	MF-403
T24	15:31661	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010446	MF-403
T5	15:31648	NTIS, PC A03/MF A01 - OSTI		DE90010447	MF-403
T6	15:31353	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010448	MF-403
T7	15:31649	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010449	MF-403
T8	15:31468	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010450	MF-403
T9	15:31650	NTIS, PC A10/MF A01 - OSTI		DE90010451	MF-403
DOE/ER/13529–					
2	15:30910	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009732	MF-401
DOE/ER/13916–					
T2	15:31747	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010627	MF-411
DOE/ER/13930–					
T1	15:30969	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010810	MF-401
DOE/ER/13971–					
6	15:31708	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010666	MF-411
DOE/ER/14012–					
1	15:30999	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008975	MF-406
DOE/ER/25019–					
15	15:31917	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010422	MF-406; MF-405
17	15:31709	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010428	MF-406
DOE/ER/40048–					
235-LO	15:31043	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010490	MF-414
DOE/ER/40085–					
19	15:31827	NTIS, PC A10/MF A01; OSTI; INIS		DE90010662	MF-414
DOE/ER/40150–					
T1	15:31044	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010523	MF-414
DOE/ER/40154–					
T2	15:31855	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010792	MF-413
DOE/ER/40315–					
172	15:31761	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010520	MF-414
173	15:31762	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010126	MF-414
DOE/ER/40345–					
14	15:31833	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010421	MF-413
DOE/ER/40427–					
04-N90	15:31765	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010429	MF-413
28-N9	15:31856	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010425	MF-413
31-N9	15:31857	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010426	MF-413
DOE/ER/40475–					
2	15:30319	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010049	MF-413

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3	15:31850	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010050	MF-413
DOE/ER/45057–					
5	15:30664	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010661	MF-404
DOE/ER/45139–					
5	15:30665	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010579	MF-404
DOE/ER/53263–					
8	15:31980	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010519	MF-420
DOE/ER/60039–					
T4	15:31555	NTIS, PC A03/MF A01 - OSTI		DE90010594	MF-407
DOE/ER/60310–					
2	15:31422	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010468	MF-402
DOE/ER/60400–					
4	15:30929	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009963	MF-401
DOE/ER/60473–					
T1	15:31710	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010793	MF-410
DOE/ER/60487–					
4	15:31556	NTIS, PC A02/MF A01; OSTI; INIS		DE90010034	MF-408
DOE/ER/60587–					
2	15:31546	NTIS, PC A02/MF A01; GPO Dep.	E 1.99:	DE90010524	MF-408
DOE/ER/60592–					
T3	15:31593	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009738	MF-407
DOE/ER/60848–					
1	15:31558	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009956	MF-408
DOE/ET/10815–					
142	15:30285	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009967	MF-112
DOE/ET/53088–					
6	15:31938	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010789	MF-420
DOE/FE–					
0171	15:30492	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008197	MF-101
0173P	15:30493	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008211	MF-103; MF-104; MF-105; MF-107;
0175P	15:29935	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010271	MF-102
0176P	15:29981	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010270	MF-106
0177P	15:29982	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010269	MF-107
0179P	15:30019	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010268	MF-103
0181P	15:30020	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010267	MF-104
0184P	15:29944	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010266	MF-109
0185P	15:29983	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010265	MF-105
DOE/FE/61694–					
T1	15:30494	National Academy Press, 2101 Constitution Avenue, N.W. Washington, DC 20418 $24.50			
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10245	15:30374	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010861	MF-523
10282	15:30666	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009900	MF-312
DOE/ID/12756–					
1-Vol.2	15:30271	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010575	MF-251
DOE/MC/11076–					
2759	15:30092	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000413	PC-123
2788	15:30091	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000457	MF-123
DOE/MC/22118–					
2818	15:29984	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010051	MF-106
DOE/MC/23075–					
2814	15:29945	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010628	MF-109
DOE/MC/23077–					
2800	15:30286	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000456	MF-109
DOE/MC/23161–					
2806	15:29946	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000466	MF-109
DOE/MC/23167–					
2812	15:30021	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010052	MF-111
DOE/MC/25043–					
2804	15:30087	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000464	MF-123
DOE/MC/26387–					
2810	15:29996	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000469	MF-101
DOE/METC–					
90/4096	15:30022	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000471	MF-103
DOE/NE/34122–					
1	15:30320	NTIS (US Sales Only), PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009324	PC-523

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DOE/OR/21548–					
120	15:30117	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010660	MF-511
DOE/OR/21864–					
4	15:31471	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010626	MF-511
DOE/PC/79813–					
T3	15:29947	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007647	PC-108
T4	15:29948	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007648	PC-108
DOE/PC/79854–					
T10	15:30308	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010029	MF-105
T2	15:30302	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010009	MF-105
T3	15:30303	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010022	MF-105
T4	15:30304	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010023	MF-105
T5	15:30305	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010024	MF-105
T7	15:30306	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010026	MF-105
T9	15:30307	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010028	MF-105
DOE/PC/80502–					
T17	15:29949	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009794	MF-108
DOE/PC/88812–					
T6	15:29950	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009556	MF-108
DOE/PC/88861–					
T18	15:29968	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010591	MF-105
DOE/PC/89759–					
T1	15:29951	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009839	MF-104
DOE/PC/89851–					
T2	15:29952	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009841	MF-108
DOE/PC/89904–					
T6	15:29969	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010587	MF-102
T7	15:29970	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010588	MF-105
T8	15:29971	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010589	MF-102
T9	15:29972	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010590	MF-105
DOE/PC/89908–					
T1	15:29936	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009557	MF-102
DOE/PC/90007–					
T1	15:29953	NTIS, PC A24/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009553	PC-108
DOE/PC/90279–					
T17	15:30023	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009902	MF-104
T18	15:30024	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009903	MF-104
T19	15:30025	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009904	MF-104
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89-28	15:30118	NTIS, PC A16/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008223	MF-511
DOE/RL/01830–					
P-H4-Vol.1	15:30520	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008226	MF-350
P-H4-Vol.2	15:30521	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008212	MF-350; MF-920
DOE/RW–					
0262	15:30119	OSTI; INIS		TI90010063	MF-800
DOE/S–					
90010604	15:30120	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010604	MF-902
DOE/SF/16306–					
21	15:30260	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010107	MF-231
DOE/SR/10749–					
T4	15:30453	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009735	MF-702
T5	15:30454	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009736	MF-702
T6	15:30455	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009737	MF-702
DOE/WIPP–					
89-011-Rev.0	15:30121	NTIS, PC A11/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010531	MF-721
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5066	15:30851	*See* N–90-12659			
EC–					
90-02368	15:30461	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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EC/CWS–					
TR68	15:30062	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
EC/NHRIS–					
88018	15:31473	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
EC/NWRI–					
90-01262	15:31474	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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DR3-PMD89-8	15:31355	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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90-02366	15:30476	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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IP90	15:30579	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ECA–					
89-PA-CSS11	15:30495	PC Environment Council of Alberta, 8th Floor, Weber Centre, 5555 Calgary Trail, Edmonton, AB, CAN T6H 5P9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ECN–					
89-185	15:30891	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
89-191	15:30892	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
ECN-I–					
90-5	15:30843	NTIS (US Sales Only), PC A03/MF A01		DE90767905	
EGG–					
10617-1013	15:31423	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010062	MF-940
2589	15:31858	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008239	PC-405; PC-505
EGG-EA–					
8245-Vol.2	15:30429	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010654	MF-506
EGG-EAST–					
8608	15:30375	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010923	MF-523
8984	15:30376	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010906	MF-520
EGG-EST–					
8946	15:31642	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009806	MF-507
EGG-M–					
88360	15:30960	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009761	MF-820
89048	15:31312	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009481	MF-506

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90055	15:30596	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009643	MF-312
EMR–					
CE02998	15:30216	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST			
EMR/EFA–					
90-02347	15:30470	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
EMR/OEC–					
CE02986	15:30607	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
EPA–					
230/01-90/073	15:31392	*See* PB–90-173469/XAB			
230/05-89/051	15:31384	*See* PB–90-171968/XAB			
230/05-89/054	15:31391	*See* PB–90-173238/XAB			
230/05-89/055	15:31387	*See* PB–90-172297/XAB			
230/05-89/056	15:31386	*See* PB–90-172230/XAB			
230/05-89/060	15:31390	*See* PB–90-173188/XAB			
230/07-87/029	15:31396	*See* PB–90-178302/XAB			
400/1-89/001A	15:31375	*See* PB–90-167370/XAB			
400/1-89/001B	15:31376	*See* PB–90-167388/XAB			
400/1-89/001C	15:31377	*See* PB–90-167396/XAB			
400/1-89/001D	15:31378	*See* PB–90-167404/XAB			
520/1-89/012	15:31441	*See* PB–90-168063/XAB			
520/1-89/020	15:31369	*See* PB–90-160086/XAB			
520/5-89/034	15:31404	*See* PB–90-182197/XAB			
530/SW-89/051	15:30608	*See* PB–90-163106/XAB			
530/SW-90/011A	15:31480	*See* PB–90-166125/XAB			
530/SW-90/011B	15:31481	*See* PB–90-166133/XAB			
530/SW-90/011C	15:31439	*See* PB–90-166141/XAB			
530/SW-90/011D	15:31482	*See* PB–90-166158/XAB			
530/SW-90/011E	15:31370	*See* PB–90-166166/XAB			
530/SW-90/011F	15:31483	*See* PB–90-166174/XAB			
530/SW-90/011G	15:31484	*See* PB–90-166182/XAB			
530/SW-90/011H	15:31485	*See* PB–90-166190/XAB			
530/SW-90/011I	15:31440	*See* PB–90-166208/XAB			
530/SW-90/011J	15:31486	*See* PB–90-166216/XAB			
530/SW-90/011K	15:31487	*See* PB–90-166224/XAB			
530/SW-90/011L	15:31488	*See* PB–90-166232/XAB			
530/SW-90/011M	15:31489	*See* PB–90-166240/XAB			
530/SW-90/011N	15:31490	*See* PB–90-166257/XAB			
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530/SW-90/011P	15:31492	*See* PB–90-166273/XAB			
530/SW-90/011Q	15:31493	*See* PB–90-166281/XAB			
530/SW-90/011R	15:31494	*See* PB–90-166299/XAB			
530/SW-90/011S	15:31495	*See* PB–90-166307/XAB			
530/SW-90/011T	15:31496	*See* PB–90-166315/XAB			
530/SW-90/011U	15:31497	*See* PB–90-166323/XAB			
530/SW-90/011V	15:31498	*See* PB–90-166331/XAB			
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530/SW-90/011Y	15:31501	*See* PB–90-166364/XAB			
530/SW-90/011Z	15:31371	*See* PB–90-166372/XAB			
530/SW-90/012A	15:31503	*See* PB–90-166398/XAB			
530/SW-90/012B	15:31504	*See* PB–90-166406/XAB			
530/SW-90/012C	15:31505	*See* PB–90-166414/XAB			
530/SW-90/012D	15:31506	*See* PB–90-166422/XAB			
530/SW-90/012E	15:31507	*See* PB–90-166430/XAB			
530/SW-90/012F	15:31508	*See* PB–90-166448/XAB			
530/SW-90/012G	15:31509	*See* PB–90-166455/XAB			
530/SW-90/012H	15:31510	*See* PB–90-166463/XAB			
530/SW-90/012I	15:31511	*See* PB–90-166471/XAB			
530/SW-90/012J	15:31512	*See* PB–90-166489/XAB			

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EPA–					
530/SW-90/012K	15:31513	*See* PB–90-166497/XAB			
530/SW-90/012L	15:31514	*See* PB–90-166505/XAB			
530/SW-90/012M	15:31515	*See* PB–90-166513/XAB			
530/SW-90/012N	15:31372	*See* PB–90-166521/XAB			
530/SW-90/012O	15:31516	*See* PB–90-166539/XAB			
530/SW-90/012P	15:31517	*See* PB–90-166547/XAB			
530/SW-90/012Q	15:31518	*See* PB–90-166554/XAB			
530/SW-90/012R	15:30061	*See* PB–90-166562/XAB			
600/7-90/005	15:31389	*See* PB–90-172586/XAB			
EPA/ROD/R–					
02-89/083	15:31528	*See* PB–90-178013/XAB			
02-89/085	15:31539	*See* PB–90-178898/XAB			
02-89/086	15:31536	*See* PB–90-178559/XAB			
02-89/091	15:31445	*See* PB–90-178179/XAB			
02-89/093	15:31531	*See* PB–90-178104/XAB			
02-89/097	15:31538	*See* PB–90-178849/XAB			
03-89/076	15:31532	*See* PB–90-178112/XAB			
03-89/081	15:31530	*See* PB–90-178047/XAB			
04-89/050	15:30066	*See* PB–90-178880/XAB			
04-89/051	15:31535	*See* PB–90-178542/XAB			
05-89/098	15:31447	*See* PB–90-178518/XAB			
05-89/101	15:31437	*See* PB–90-153719/XAB			
05-89/103	15:31446	*See* PB–90-178187/XAB			
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05-89/117	15:31529	*See* PB–90-178021/XAB			
05-89/118	15:31450	*See* PB–90-178872/XAB			
06-89/050	15:31448	*See* PB–90-178526/XAB			
07-89/026	15:31478	*See* PB–90-162637/XAB			
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07-89/030	15:31534	*See* PB–90-178534/XAB			
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09-89/037	15:31525	*See* PB–90-177833/XAB			
09-89/043	15:31537	*See* PB–90-178831/XAB			
09-89/044	15:31395	*See* PB–90-177874/XAB			
10-89/020	15:31540	*See* PB–90-178906/XAB			
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02-89/092	15:31527	*See* PB–90-177866/XAB			
EPRI-CU–					
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6480-Vol.10	15:30377	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6720-M	15:30353	Research Reports Center, Box 50490, Palo Alto, CA 94303			

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6810	15:30340	Research Reports Center, Box 50490, Palo Alto, CA 94303			
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1164	15:30196	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
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7050	15:30198	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
ETSU-SSH–					
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4065	15:30235	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
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4048-P1	15:30274	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
4070	15:30275	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
ETSU-WN–					
1063	15:30278	the British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
EUR–					
12059	15:30327	NTIS (US Sales Only), PC A04/MF A01			
12060	15:31279	NTIS (US Sales Only), PC A04/MF A01			
12064	15:31577	NTIS (US Sales Only), PC A99/MF A01			
12077(1)	15:30123	NTIS (US Sales Only), PC A10/MF A01			
12077(2)	15:30124	NTIS (US Sales Only), PC A10/MF A01			
12134	15:30125	NTIS (US Sales Only), PC A04/MF A01			
12141(1)	15:30126	NTIS (US Sales Only), PC A18/MF A01			
12141(2)	15:30127	NTIS (US Sales Only), PC A20/MF A01			
12175	15:30378	NTIS (US Sales Only), PC A07/MF A01			
12186	15:30328	NTIS (US Sales Only), PC A04/MF A01			
12191	15:31356	NTIS (US Sales Only), PC A05/MF A01			
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12251	15:30325	NTIS (US Sales Only), PC A05/MF A01			
12264	15:30130	NTIS (US Sales Only), PC A05/MF A01			
12321	15:30329	NTIS (US Sales Only), PC A03/MF A01			
FDRIN–					
0001	15:31349	*See* CNIC–00215			
0002	15:31350	*See* CNIC–00220			
FNAL-TM–					
1654	15:31127	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008210	PC-406; PC-414
FNAL/C–					
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90/33-E	15:31764	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010527	MF-414
90/34-E	15:31786	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010528	MF-414
90/72-T	15:31909	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010663	MF-412

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FO–					
90-02160	15:31475	PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-02285	15:31476	PC Fisheries and Oceans Canada, Scientific Publications, 200 Kent St, 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
FO/CAR–					
89-04814	15:31594	PC Canada Dept. of Fisheries and Oceans, Scientific Publications, 200 Kent St., 14th Floor, Ottawa, ON, CAN K1A 0E6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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261	15:30845	NTIS (US Sales Only), PC A12/MF A01		DE90784632	
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249	15:30245	NTIS (US Sales Only), PC A12/MF A01		DE90784617	
254	15:30844	NTIS (US Sales Only), PC A10/MF A01		DE90784615	
256	15:30667	NTIS (US Sales Only), PC A09/MF A01		DE90784613	
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3577	15:30268	NTIS (US Sales Only), PC A21/MF A01		DE90784619	
3579	15:30445	NTIS (US Sales Only), PC A09/MF A01		DE90784616	
FSC–					
CE02972	15:30597	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
FSRP-NC–					
290	15:31442	*See* PB–90-168493/XAB			
FSRP-RM–					
287	15:30209	*See* PB–90-179854/XAB			
GA-A–					
19876	15:30512	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008227	MF-224
19922	15:31981	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008232	PC-420
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GD-ITA–					
0022	15:31273	*See* CNIC–00222			
GKSS–					
88/E/55	15:31595	NTIS (US Sales Only), PC A17/MF A01		DE90784862	
89/E/30	15:30980	GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.)			
GKYA–					
86-6258	15:30522	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
GL-TR–					
89-0342	15:31676	*See* AD-A–216856/5/XAB			
GRI–					
86/7019	15:30079	*See* PB–90-167636/XAB			
GRS-F–					
177	15:30379	NTIS (US Sales Only), PC A16/MF A01		DE90784999	
178	15:30380	NTIS (US Sales Only), PC A03/MF A01		DE90784920	

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GS/AR–					
Bull58	15:31424	PC Geological Survey of Canada, Publications Distribution, 601 Booth St, Ottawa, ON, CAN K1A 0E8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $15.00 CAN; MF $10 CAN			
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14/89	15:31579	NTIS (US Sales Only), PC A13/MF A01		DE90785001	
15/89	15:31580	NTIS (US Sales Only), PC A11/MF A01		DE90785002	
18/89	15:30131	NTIS (US Sales Only), PC A04/MF A01		DE90784904	
GSF-TL–					
26/89	15:30131	*See* GSF–18/89			
GSI–					
84-16	15:31982	NTIS (US Sales Only), PC A06/MF A01		DE90784792	
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90-09(prepr.)	15:31045	Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)			
90-10(prepr.)	15:31680	NTIS (US Sales Only), PC A02/MF A01		DE90785014	
HETA–					
87-367-1987	15:31402	*See* PB–90-180696/XAB			
HGC–					
0001	15:31420	*See* CNIC–00258			
HMI-B–					
465	15:30246	NTIS (US Sales Only), PC A07/MF A01		DE90785028	
HSM–					
73-11000	15:31627	*See* PB–90-180605/XAB			
HW–					
3-1406	15:30369	NTIS, PC A08/MF A01 - OSTI		DE90010739	MF-700
IAE–					
0026	15:30098	*See* CNIC–00092			
0029	15:30113	*See* CNIC–00097			
0039	15:30102	*See* CNIC–00166			
0040	15:30115	*See* CNIC–00167			
0041	15:30103	*See* CNIC–00168			
0047	15:30355	*See* CNIC–00235			
0051	15:31679	*See* CNIC–00239			
0054	15:31274	*See* CNIC–00242			
0056	15:31124	*See* CNIC–00244			
0058	15:31818	*See* CNIC–00246			
0065	15:31275	*See* CNIC–00253			
0066	15:31886	*See* CNIC–00254			
IAEA-AL–					
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026	15:30895	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625997	
IAEA-HPRA–					
14	15:31643	NTIS (US Sales Only), PC A11/MF A01; OSTI; INIS		DE90627130	
IAEA-INFCIRC–					
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IAEA-TECDOC–					
539	15:31567	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626559	
IAEA-WMRA–					
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513	15:31337	*See* AD-A–217610/5/XAB			
IFUSP-P–					
750	15:31829	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625900	
790	15:31809	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625289	
IKE–					
2-89	15:31360	NTIS (US Sales Only), PC A09/MF A01		DE90784838	
INDC(BZL)–					
032/L	15:32035	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627117	
INDC(EGY)–					
005/L	15:31280	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626951	
INDC(NDS)–					
232/L	15:31820	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90625883	
INIS-BR–					
2047	15:31711	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625342	
INIS-XN–					
200	15:30322	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626840	
INIS-mf–					
12573	15:31426	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90626283	
12578	15:30348	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90627049	
INP–					
1344/PS	15:31860	NTIS (US Sales Only), PC A16/MF A01; OSTI; INIS		DE90625708	
IPEN-PUB–					
284	15:30132	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627015	
IPF–					
88-3	15:31941	NTIS (US Sales Only), PC A03/MF A01		DE90784789	
IPP–					
1/249	15:31942	NTIS (US Sales Only), PC A03/MF A01		DE90784791	
2/303	15:31943	NTIS (US Sales Only), PC A03/MF A01		DE90784790	
IPPCZ–					
294	15:31944	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623615	
IRTA–					
CE02941	15:30524	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4. Prices: PRICES UPON REQUEST			
ISH–					
128	15:31427	Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene			
ISTIC-TR-C–					
000208	15:30014	*See* PB–90-176041/XAB			
000209	15:30015	*See* PB–90-176058/XAB			
000211	15:30034	*See* PB–90-176025/XAB			
ITP-SB–					
89-40	15:31808	*See* DOE/ER/01545–440			
89-93	15:31807	*See* DOE/ER/01545–438			
IWS–					
146.18	15:31385	*See* PB–90-172032/XAB			
JA–					
6272	15:30990	*See* AD-A–217590/9/XAB			
6309	15:30986	*See* AD-A–217562/8/XAB			
6329	15:30989	*See* AD-A–217587/5/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
6347	15:30987	*See* AD-A–217563/6/XAB			
6363	15:30737	*See* AD-A–217508/1/XAB			
JPL-D–					
6846	15:30511	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010057	MF-362
6847	15:30951	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010058	MF-362
Juel–					
2303	15:30668	NTIS (US Sales Only), PC A07/MF A01		DE90784860	
2311	15:31282	NTIS (US Sales Only), PC A05/MF A01		DE90785112	
2337	15:31363	NTIS (US Sales Only), PC A04/MF A01		DE90785125	
Juel-Conf–					
76	15:30669	NTIS (US Sales Only), PC A16/MF A01		DE90784758	
Juel-Spez–					
337	15:31983	Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentralbibliothek			
K/QT–					
214	15:30846	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010894	MF-501
238	15:31283	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010892	MF-506
KCP–					
613-4232	15:30961	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010595	MF-706
KEMA–					
70196-WPB-88-375	15:30292	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
88-431	15:30290	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
88-602	15:30291	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
88-617	15:29985	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
89-3013	15:30247	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
89-3015	15:30255	NV Tot Keuring van Elektrotechnische Materialen (KEMA), P.O. Box 9035, 6800 ET Arnhem, Netherlands			
KFK–					
4582	15:32021	NTIS (US Sales Only), PC A05/MF A01		DE90785126	
4603	15:31984	NTIS (US Sales Only), PC A07/MF A01		DE90785127	
4669	15:30670	NTIS (US Sales Only), PC A08/MF A01		DE90784894	
4672	15:30107	NTIS (US Sales Only), PC A04/MF A01		DE90785074	
4688	15:31320	NTIS (US Sales Only), PC A05/MF A01		DE90784802	
LA–					
11211-Vol.1	15:30011	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010078	
11625-MS	15:31882	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010675	MF-701; MF-704
11629-T	15:30338	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010674	MF-520
11641-MS	15:31892	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010815	MF-700
11807	15:30339	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010199	PC-700; PC-528
11809-MS	15:31332	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008213	MF-731
11813-MS	15:30272	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008217	MF-251
11815-MS	15:30763	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010653	MF-404
LA-UR–					
90-1123	15:31682	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010565	MF-700
90-1125	15:31000	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010566	MF-900
90-1142	15:31128	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010567	MF-414
90-1196	15:31662	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010568	MF-403
90-1197	15:31663	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010569	MF-403
90-1198	15:31664	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010570	MF-403
90-1242	15:31766	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010571	MF-700
90-1247	15:31068	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010572	MF-705
90-1251	15:30133	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010573	MF-721
90-1275	15:31894	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010584	MF-701; MF-700
90-1303	15:30170	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010586	MF-706
90-1310	15:30847	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010596	MF-704
90-1313	15:30764	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010597	MF-404; MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
LA-UR–					
90-1354	15:31895	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010602	
90-1360	15:31876	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010603	MF-413
90-1366	15:31945	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010607	MF-427
90-1368	15:30848	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010608	MF-904
90-1373	15:30849	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010610	MF-404
90-1374	15:30970	NTIS, PC A03/MF A01 - OSTI		DE90010611	
90-1390	15:31810	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010613	MF-414
90-1402	15:31910	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010614	MF-910
90-1433	15:31326	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010615	
90-1434	15:31313	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010616	
90-1439	15:30671	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010620	MF-404
90-1461	15:30134	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010621	MF-814
LAIR–					
412	15:31590	*See* AD-A–217347/4/XAB			
414	15:31587	*See* AD-A–217264/1/XAB			
417	15:31589	*See* AD-A–217346/6/XAB			
419	15:31588	*See* AD-A–217345/8/XAB			
LAMP–					
89/1	15:31712	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625343	
89/2	15:31893	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625397	
89/3	15:31713	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625344	
LAPP-TH–					
268/89	15:31814	*See* NORDITA–89/41-P(prepr.)			
LBL–					
28700	15:31111	*See* BNL–44516			
LIHMPH–					
0001	15:31465	*See* CNIC–00205			
LIS–					
80	15:31615	NTIS (US Sales Only), PC A10/MF A01		DE90785003	
89	15:31364	NTIS (US Sales Only), PC A05/MF A01		DE90785034	
LP/RB–					
BP198E	15:30462	PC Library of Parliament of Canada, Parliament Buildings, Ottawa, ON, CAN K1A 0A9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
LRC–					
90-13	15:31980	*See* DOE/ER/53263–8			
LU-TP–					
89-10	15:31788	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625642	
89-16	15:31789	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625643	
LUIP–					
8811	15:31821	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625880	
8910	15:31822	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625887	
LUNFD6-NFFK–					
7107-1-10-1989	15:31822	*See* LUIP–8910			
MBB-Z–					
0251-89-PUB	15:30248	NTIS (US Sales Only), PC A02/MF A01		DE90780254	
MEW–					
89-4	15:31365	PC Manitoba Environment and Workplace Safety and Health, 450 Broadway Ave., Room 156, Legislative Bldg., Winnipeg, MB, CAN R3C 0V8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MEW/RAC–					
90-00446	15:30463	PC Manitoba Environment and Workplace Safety and Health, 450 Broadway Ave., Room 156, Legislative Bldg., Winnipeg, MB, CAN R3C 0V8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

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MH–					
90-02356	15:30233	PC Manitoba Hydro, 820 Taylor Ave, PO Box 815, Winnipeg, MB, CAN R3C 2P4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
MHETA–					
89-009-1990	15:30036	*See* PB–90-179284/XAB			
MICROLOG–					
89-04534	15:31591	*See* CWS/SF–67E			
89-04535	15:31592	*See* CWS/SF–67F			
89-04814	15:31594	*See* FO/CAR–89-04814			
89-05565	15:30600	*See* NP–SPE3/HA/6			
89-05632	15:30222	*See* CHA–89-05632			
89-05738	15:30250	*See* WU–89-05738			
89-05739	15:30254	*See* TES–89-05739			
89-06354	15:30522	*See* GKYA–86-6258			
90-00163	15:30525	*See* NRC/IRC–28134			
90-00183	15:30055	*See* TU/CEA–90-00183			
90-00405	15:30309	*See* OH/RD–89-95-K			
90-00418	15:30225	*See* OH/RD–89-181-K			
90-00421	15:30440	*See* OH/RD–89-105-K			
90-00423	15:30310	*See* OH/RD–89-229-K			
90-00446	15:30463	*See* MEW/RAC–90-00446			
90-01173	15:30441	*See* OH/RD–89-129-K			
90-01178	15:30442	*See* OH/RD–89-139-K			
90-01218	15:30496	*See* BCH–90-01218			
90-01262	15:31474	*See* EC/NWRI–90-01262			
90-01263	15:30459	*See* CCME–TS/WM-TRE008-E			
90-01417	15:30580	*See* MU/CRT–638			
90-01418	15:30581	*See* MU/CRT–639			
90-01423	15:30582	*See* MU/CRT–640			
90-01424	15:30583	*See* MU/CRT–641			
90-01425	15:30584	*See* MU/CRT–642			
90-01726	15:30456	*See* OME–90-01726			
90-01762	15:30071	*See* BC/P–90-01762			
90-01796	15:31424	*See* GS/AR–Bull58			
90-01802	15:30063	*See* OME/WRB–90-01802			
90-01880	15:30464	*See* OWMC–90-01880			
90-01892	15:30462	*See* LP/RB–BP198E			
90-01895	15:31367	*See* OWMC–90-01895			
90-01924	15:30070	*See* PACE–88-4			
90-01935	15:30064	*See* PACE–87-2			
90-01995	15:30074	*See* CRPC–90-01995			
90-02012	15:30316	*See* OE–90-02012			
90-02159	15:30480	*See* TC–90-02159			
90-02160	15:31475	*See* FO–90-02160			
90-02168	15:30534	*See* PWC/AES–1-4:86-18			
90-02169	15:30533	*See* PWC/AES–1-4:86-17			
90-02178	15:30537	*See* PWC/AES–1-4:86-46			
90-02179	15:30536	*See* PWC/AES–1-4:86-45			
90-02180	15:30535	*See* PWC/AES–1-4:86-20			
90-02194	15:31352	*See* CPS–EPS7/AP/21			
90-02227	15:30200	*See* NSLF–7			
90-02250	15:30487	*See* CMHC–90-02259			
90-02257	15:30060	*See* PMA–90-02257			
90-02273	15:30059	*See* NSAEC–90-02273			
90-02283	15:30458	*See* AOSTRA–90-02283			
90-02285	15:31476	*See* FO–90-02285			
90-02294	15:30495	*See* ECA–89-PA-CSS11			
90-02313	15:30457	*See* SCC–90-02313			
90-02328	15:30276	*See* NRC/E–TM-WE010			
90-02347	15:30470	*See* EMR/EFA–90-02347			
90-02350	15:31365	*See* MEW–89-4			
90-02356	15:30233	*See* MH–90-02356			
90-02366	15:30476	*See* EC/SEB–90-02366			
90-02368	15:30461	*See* EC–90-02368			
90-02377	15:31355	*See* EC/RRE–DR3-PMD89-8			
90-02382	15:30579	*See* EC/TS–IP90			
90-02384	15:31354	*See* EC–IP101			

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90-02385	15:30062	*See* EC/CWS–TR68			
90-02386	15:31473	*See* EC/NHRIS–88018			
90-02407	15:31366	*See* OE–90-02407			
MISC–					
89070	15:30374	*See* DOE/ID–10245			
MLM–					
3616(OP)	15:30850	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010081	MF-704
3632	15:30182	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008229	MF-700
3633(OP)	15:31314	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010080	MF-700
MPI-PAE/Exp.El.–					
217	15:31284	Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik			
220	15:31767	Also published in Z. Phys., C (May 1990) v. 46(4) p. 563-567			
221	15:31768	NTIS (US Sales Only), PC A03/MF A01		DE90785075	
MU/CRT–					
638	15:30580	PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
639	15:30581	PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
640	15:30582	PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
641	15:30583	PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
642	15:30584	PC Centre de recherche sur les transports, Universite de Montreal, CP 6128, Succursale A, Montreal, PQ, CAN H3C 3J7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
N–					
90-12659	15:30851	NTIS, PC A03/MF A01			
NAMB–					
451	15:30640	*See* PB–90-171612/XAB			
NAS–					
1.15:102355	15:30851	*See* N–90-12659			
NASA-TM–					
102355	15:30851	*See* N–90-12659			
NBES–					
2014	15:30598	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
2025	15:30615	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			

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2040	15:30599	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
2064	15:30220	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
NBI-HE–					
90-02	15:31811	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625292	
90-04	15:31812	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625293	
90-06	15:31813	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625295	
NEI-SE–					
56	15:30208	NTIS (US Sales Only), PC A04/MF A01		DE90770776	
NERDI–					
0005	15:30357	*See* CNIC–00229			
NIC–					
0001	15:30886	*See* CNIC–00109			
NIPER–					
471	15:30053	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010033	MF-122; MF-125
NIST/TN–					
1272	15:30367	*See* PB–90-169996/XAB			
NOAA-TM-ERL-ARL–					
180	15:31397	*See* PB–90-179896/XAB			
NOAA-TM-ERL-WPL–					
174	15:31401	*See* PB–90-180670/XAB			
NOAA-TM-NMFS–					
86	15:31521	*See* PB–90-173915/XAB			
NORDITA–					
89/41-P(prepr.)	15:31814	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625296	
NOSC/TD–					
1677	15:30443	*See* AD-A–216765/8/XAB			
NP–					
SPE3/HA/6	15:30600	PC Environment Canada, Departmental Library, Ottawa, ON, CAN K1A 0H3; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NRC/E–					
TM-WE010	15:30276	PC National Research Council of Canada, Publication Sales and Distribution Office, Montreal Road, Ottawa, ON, CAN K1A 0R6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NRC/IRC–					
28134	15:30525	PC Canada Institute for Scientific and Technical Information, Montreal Rd, Ottawa, ON, CAN K1A 0R6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $3.00 CAN; MF $10 CAN			
NRL-MR–					
6545	15:31034	*See* AD-A–217604/8/XAB			
6600	15:31926	*See* AD-A–217605/5/XAB			
NRPB-R–					
230	15:31285	H.M. Stationery Office, London, price Pound 7.00			
NSAEC–					
90-02273	15:30059	PC Newfoundland Statistics Agency, Executive Council, P.O. Box 8700, St John's, NF, CAN A1B 4J6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
NSLF–					
7	15:30200	PC Nova Scotia Dept. of Lands and Forests, Toronto-Dominion Bank Bldg., 1791 Barrington St., PO Box 698, Halifax, NS, CAN B3J 2T9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
NSS/R–					
155	15:30135	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90627027	
166	15:30136	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90627028	
NTP-TR–					
361	15:31617	*See* PB–90-170895/XAB			
NUREG–					
0430-Vol.9-No.2	15:30171	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90009734	
0540-Vol.12-No.1	15:30341	NTIS, PC A15/MF A01 - GPO; OSTI; INIS		TI90010670	
0750-Vol.31-No.2	15:30342	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90009733	
0936-Vol.9-No.1	15:30343	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90010631	
1125-Vol.11	15:30344	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90010617	
1394	15:30381	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90010817	
1402	15:30382	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90010748	
1404	15:30172	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90010076	
1405	15:30183	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90010818	
O797-Suppl.24	15:30418	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90009639	
NUREG/CR–					
1667	15:30137	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90010074	
2000-Vol.9-No.3	15:30345	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90010564	
4550-Vol.5-Rev.1-Pt.1	15:30414	NTIS, PC A17/MF A01 - GPO; OSTI; INIS		TI90010760	
4550-Vol.5-Rev.1-Pt.2	15:30415	NTIS, PC A99/MF A01 - GPO; OSTI; INIS		TI90010761	
4753-Vol.3	15:31665	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90010559	
4753-Vol.4	15:31666	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90010560	
5258-Vol.2	15:31667	NTIS, PC A04/MF A01 - GPO - OSTI		TI90010563	
5395	15:30377	*See* EPRI-NP–6480-Vol.10			
5514	15:30416	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90010518	
5548	15:30138	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90010562	
NUREG/IA–					
0018	15:30417	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90010669	
OE–					
90-02012	15:30316	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-02407	15:31366	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OH/RD–					
89-105-K	15:30440	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-129-K	15:30441	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			

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89-139-K	15:30442	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-181-K	15:30225	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-229-K	15:30310	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
89-95-K	15:30309	PC Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $10.00 CAN; MF $10 CAN			
OME–					
90-01726	15:30456	PC Ontario Ministry of Energy, Communications Services Group, 62 Wellesley St., West, Main Floor, Toronto, ON, CAN M7A 2B7; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
OME/WRB–					
90-01802	15:30063	PC Ontario Ministry of the Environment, Public Information Office, 135 St. Clair Ave. West, Toronto, ON, CAN M4V 1P5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
ONRFE-M–					
7	15:30852	*See* PB–90-174392/XAB			
ORNL–					
6541/V2/P3	15:30477	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010064	MF-400
ORNL/ATD–					
35	15:30974	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010893	MF-706
ORNL/FTR–					
3561	15:30526	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010008	MF-350
3581	15:30326	NTIS, PC A03/MF A01 - OSTI		DE90010618	
3589	15:31286	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010630	MF-332
3590	15:31287	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010110	MF-406
3594	15:30317	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010011	MF-400
3595	15:30330	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010010	MF-522
3598	15:31288	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010556	MF-413
3599	15:30139	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010813	MF-721
3601	15:30675	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010629	MF-404
3602	15:30505	NTIS, PC A03/MF A01 - OSTI		DE90010539	
3605	15:30765	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010799	MF-404
ORNL/M–					
1133	15:30527	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008216	MF-350
1164	15:31581	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010430	MF-407
ORNL/NSIC–					
200-Vol.9-No.3	15:30345	*See* NUREG/CR–2000-Vol.9-No.3			
ORNL/TM–					
11119	15:31436	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010012	MF-511
11276	15:31327	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008215	
11451	15:30416	*See* NUREG/CR–5514			
11514	15:31339	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008214	MF-700
11530	15:31001	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008220	MF-406
OSFP/PC–					
0017	15:30094	*See* PB–90-177031/XAB			

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OWMC–					
90-01880	15:30464	PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
90-01895	15:31367	PC Ontario Waste Management Corporation, 2 Bloor St. West, 11th. Fl., Communications Service, Toronto, ON, CAN M4W 3E2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
PACE–					
87-2	15:30064	PC Petroleum Association for Conservation of the Canadian Environment (PACE), 1202-275 Slater St., Ottawa, ON, CAN K1P 5H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
88-4	15:30070	PC Petroleum Association for Conservation of the Canadian Environment (PACE), 1202-275 Slater St., Ottawa, ON, CAN K1P 5H9; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
PAI–					
CE02993	15:30509	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
PATENTS-USA–					
4874946/A/	15:30907				
4876115/A/	15:30515				
4876688/A/	15:30922				
4877736/A/	15:30202				
4878442/A/	15:30315				
4879086/A/	15:30363				
4879262/A/	15:30883				
4879472/A/	15:30906				
4880493/A/	15:30881				
4880508/A/	15:30882				
4880528/A/	15:30090				
4880578/A/	15:30838				
4880596/A/	15:30362				
4880608/A/	15:30314				
4881476/A/	15:30028				
4881574/A/	15:30099				
4883559/A/	15:30837				
4886401/A/	15:30966				
4886521/A/	15:29966				
4886598/A/	15:30736				
4888295/A/	15:30905				
4888485/A/	15:31419				
4888556/A/	15:31066				
4891255/A/	15:31325				
4891280/A/	15:30514				
4893234/A/	15:32033				
4895488/A/	15:30469				
4896076/A/	15:30444				
4896341/A/	15:30181				
4897556/A/	15:31238				
4899670/A/	15:30073				
Application7-444,350	15:30258	NTISPC N03/MF A01			
PB–					
90-104464/XAB	15:30478	NTISPC$39.00			
90-104480/XAB	15:30479	NTISPC$59.95			

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90-139627/XAB	15:31368	NTIS, PC A03/MF A01			
90-139668/XAB	15:30481	NTIS, PC A02/MF A01			
90-139684/XAB	15:30482	NTIS, PC A01/MF A01			
90-139825/XAB	15:30483	NTIS, PC A03/MF A01			
90-147612/XAB	15:29997	NTIS, PC A03/MF A01			
90-153164/XAB	15:29998	NTIS, PC A19/MF A03			
90-153594/XAB	15:30029	NTIS, PC A05/MF A01			
90-153602/XAB	15:30030	NTIS, PC A03/MF A01			
90-153719/XAB	15:31437	NTIS, PC A06/MF A01			
90-153826/XAB	15:31616	NTIS, PC A03/MF A01			
90-156878/XAB	15:31683	NTIS, PC A08/MF A01			
90-160086/XAB	15:31369	NTIS, PC A04/MF A01			
90-161787/XAB	15:30065	NTIS, PC A09/MF A01			
90-162603/XAB	15:31438	NTIS, PC A03/MF A01			
90-162637/XAB	15:31478	NTIS, PC A06/MF A01			
90-162983/XAB	15:30085	NTIS, PC A03/MF A01			
90-163106/XAB	15:30608	NTIS, PC A17/MF A03			
90-163148/XAB	15:30465	NTIS, PC A19/MF A03			
90-163890/XAB	15:30911	NTIS, PC A04			
90-163908/XAB	15:30912	NTIS, PC A04			
90-163916/XAB	15:31887	NTIS, PC A04			
90-166117/XAB	15:31479	NTIS, PC EE99/MF E99			
90-166125/XAB	15:31480	NTIS, PC A06/MF A01			
90-166133/XAB	15:31481	NTIS, PC A09/MF A01			
90-166141/XAB	15:31439	NTIS, PC A03/MF A01			
90-166158/XAB	15:31482	NTIS, PC A04/MF A01			
90-166166/XAB	15:31370	NTIS, PC A05/MF A01			
90-166174/XAB	15:31483	NTIS, PC A03/MF A01			
90-166182/XAB	15:31484	NTIS, PC A04/MF A01			
90-166190/XAB	15:31485	NTIS, PC A03/MF A01			
90-166208/XAB	15:31440	NTIS, PC A04/MF A01			
90-166216/XAB	15:31486	NTIS, PC A03/MF A01			
90-166224/XAB	15:31487	NTIS, PC A03/MF A01			
90-166232/XAB	15:31488	NTIS, PC A04/MF A01			
90-166240/XAB	15:31489	NTIS, PC A04/MF A01			
90-166257/XAB	15:31490	NTIS, PC A03/MF A01			
90-166265/XAB	15:31491	NTIS, PC A04/MF A01			
90-166273/XAB	15:31492	NTIS, PC A08/MF A01			
90-166281/XAB	15:31493	NTIS, PC A03/MF A01			
90-166299/XAB	15:31494	NTIS, PC A03/MF A01			
90-166307/XAB	15:31495	NTIS, PC A03/MF A01			
90-166315/XAB	15:31496	NTIS, PC A03/MF A01			
90-166323/XAB	15:31497	NTIS, PC A04/MF A01			
90-166331/XAB	15:31498	NTIS, PC A04/MF A01			
90-166349/XAB	15:31499	NTIS, PC A03/MF A01			
90-166356/XAB	15:31500	NTIS, PC A07/MF A01			
90-166364/XAB	15:31501	NTIS, PC A11/MF A02			
90-166372/XAB	15:31371	NTIS, PC A05/MF A01			
90-166380/XAB	15:31502	NTIS, PC EE99/MF E99			
90-166398/XAB	15:31503	NTIS, PC A04/MF A01			
90-166406/XAB	15:31504	NTIS, PC A11/MF A02			
90-166414/XAB	15:31505	NTIS, PC A03/MF A01			
90-166422/XAB	15:31506	NTIS, PC A04/MF A01			
90-166430/XAB	15:31507	NTIS, PC A04/MF A01			
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90-166471/XAB	15:31511	NTIS, PC A04/MF A01			
90-166489/XAB	15:31512	NTIS, PC A05/MF A01			
90-166497/XAB	15:31513	NTIS, PC A04/MF A01			
90-166505/XAB	15:31514	NTIS, PC A03/MF A01			
90-166513/XAB	15:31515	NTIS, PC A04/MF A01			
90-166521/XAB	15:31372	NTIS, PC A03/MF A01			
90-166539/XAB	15:31516	NTIS, PC A03/MF A01			
90-166547/XAB	15:31517	NTIS, PC A08/MF A01			
90-166554/XAB	15:31518	NTIS, PC A03/MF A01			
90-166562/XAB	15:30061	NTIS, PC A08/MF A01			
90-166588/XAB	15:31373	NTIS, PC A03/MF A01			
90-167339/XAB	15:29999	NTIS, PC A07/MF A01			
90-167347/XAB	15:29973	NTIS, PC A05/MF A01			
90-167362/XAB	15:31374	NTIS, PC EE99/MF E99			

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90-167370/XAB	15:31375	NTIS, PC A03/MF A01			
90-167388/XAB	15:31376	NTIS, PC A05/MF A01			
90-167396/XAB	15:31377	NTIS, PC A12/MF A02			
90-167404/XAB	15:31378	NTIS, PC A04/MF A01			
90-167511/XAB	15:31519	NTIS, PC A15/MF A02			
90-167636/XAB	15:30079	NTIS, PC A07/MF A01			
90-167701/XAB	15:30000	NTIS, PC A23/MF A03			
90-168063/XAB	15:31441	NTIS, PC A04/MF A01			
90-168493/XAB	15:31442	NTIS, PC A02/MF A01			
90-169053/XAB	15:30528	NTIS, PC A04/MF A01			
90-169988/XAB	15:30466	NTIS, PC A08/MF A01			
90-169996/XAB	15:30367	NTIS, PC A15/MF A02			
90-170002/XAB	15:31379	NTIS, PC A99/MF A04			
90-170895/XAB	15:31617	NTIS, PC A06/MF A01			
90-171331/XAB	15:29986	NTIS, PC A10/MF A02			
90-171406/XAB	15:31618	NTIS, PC A07/MF A01			
90-171414/XAB	15:31619	NTIS, PC A07/MF A01			
90-171422/XAB	15:31620	NTIS, PC A07/MF A01			
90-171430/XAB	15:31621	NTIS, PC A06/MF A01			
90-171448/XAB	15:30529	NTIS, PC A05/MF A01			
90-171455/XAB	15:31622	NTIS, PC A05/MF A01			
90-171489/XAB	15:30093	NTIS, PC A04/MF A01			
90-171521/XAB	15:31668	NTIS, PC A03/MF A01			
90-171554/XAB	15:30033	NTIS, PC A03/MF A01			
90-171570/XAB	15:31380	NTIS, PC A06/MF A01			
90-171588/XAB	15:31381	NTIS, PC A14/MF A02			
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90-171612/XAB	15:30640	NTIS, PC A05/MF A01			
90-171679/XAB	15:31684	NTIS, PC A08/MF A01			
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90-171968/XAB	15:31384	NTIS, PC A15/MF A02			
90-172032/XAB	15:31385	NTIS, PC A03/MF A01			
90-172164/XAB	15:30189	NTIS, PC A04/MF A01			
90-172222/XAB	15:30467	NTIS, PC A11/MF A02			
90-172230/XAB	15:31386	NTIS, PC A10/MF A02			
90-172297/XAB	15:31387	NTIS, PC A09/MF A01			
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90-172503/XAB	15:30080	NTIS, PC A11/MF A02			
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90-172537/XAB	15:30075	NTIS, PC A03/MF A01			
90-172545/XAB	15:31443	NTIS, PC A06/MF A01			
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90-173188/XAB	15:31390	NTIS, PC A09/MF A01			
90-173238/XAB	15:31391	NTIS, PC A11/MF A02			
90-173295/XAB	15:30003	NTIS, PC A03/MF A01			
90-173303/XAB	15:30004	NTIS, PC A03/MF A01			
90-173469/XAB	15:31392	NTIS, PC A04/MF A01			
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90-174152/XAB	15:30013	NTIS, PC A12/MF A02			
90-174392/XAB	15:30852	NTIS, PC A04/MF A01			
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90-174897/XAB	15:30609	NTIS, PC A04/MF A01			
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90-174970/XAB	15:31524	NTIS, PC A20/MF A03			
90-175449/XAB	15:30419	NTIS, PC A03/MF A01			
90-176025/XAB	15:30034	NTIS, PC A03/MF A01			
90-176041/XAB	15:30014	NTIS, PC A03/MF A01			

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90-176058/XAB	15:30015	NTIS, PC A03/MF A01			
90-177007/XAB	15:31289	NTIS, PC A03/MF A01			
90-177015/XAB	15:30676	NTIS, PC A03/MF A01			
90-177023/XAB	15:31002	NTIS, PC A04/MF A01			
90-177031/XAB	15:30094	NTIS, PC A05/MF A01			
90-177098/XAB	15:30952	NTIS, PC A03/MF A01			
90-177833/XAB	15:31525	NTIS, PC A04/MF A01			
90-177841/XAB	15:31526	NTIS, PC A04/MF A01			
90-177858/XAB	15:31444	NTIS, PC A03/MF A01			
90-177866/XAB	15:31527	NTIS, PC A06/MF A01			
90-177874/XAB	15:31395	NTIS, PC A03/MF A01			
90-177940/XAB	15:30005	NTIS, PC A03/MF A01			
90-177957/XAB	15:30006	NTIS, PC A03/MF A01			
90-178013/XAB	15:31528	NTIS, PC A06/MF A01			
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90-178047/XAB	15:31530	NTIS, PC A07/MF A01			
90-178070/XAB	15:30037	NTIS, PC A05/MF A01			
90-178096/XAB	15:30293	NTIS, PC A08/MF A01			
90-178104/XAB	15:31531	NTIS, PC A05/MF A01			
90-178112/XAB	15:31532	NTIS, PC A04/MF A01			
90-178179/XAB	15:31445	NTIS, PC A04/MF A01			
90-178187/XAB	15:31446	NTIS, PC A04/MF A01			
90-178302/XAB	15:31396	NTIS, PC A11/MF A02			
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90-178856/XAB	15:30007	NTIS, PC A15/MF A02			
90-178864/XAB	15:31449	NTIS, PC A05/MF A01			
90-178872/XAB	15:31450	NTIS, PC A03/MF A01			
90-178880/XAB	15:30066	NTIS, PC A05/MF A01			
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90-178906/XAB	15:31540	NTIS, PC A12/MF A02			
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90-182155/XAB	15:31632	NTIS, PC A09/MF A02			
90-182163/XAB	15:31633	NTIS, PC A07/MF A01			
90-182171/XAB	15:31634	NTIS, PC A07/MF A01			
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90-780362/XAB	15:30296	NTIS, PC A13/MF A02			
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90-861790/XAB	15:30767	NTISPC N01/MF N01			
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90-862434/XAB	15:30679	NTISPC N01/MF N01			
90-862509/XAB	15:30603	NTISPC N01/MF N01			
90-862517/XAB	15:30604	NTISPC N01/MF N01			
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90-862590/XAB	15:31542	NTISPC N01/MF N01			
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90-862640/XAB	15:30605	NTISPC N01/MF N01			
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90-02257	15:30060	PC Petroleum Monitoring Agency, 580 Booth St., Ottawa, ON, CAN K1A 0E4; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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7285	15:30138	*See* NUREG/CR–5548			
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2030/TR-727	15:30676	*See* PB–90-177015/XAB			
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PUC-DF-NC–					
04/81	15:30039	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626003	
PWA–					
72/89	15:30107	*See* KFK–4672			
PWC/AES–					
1-4:86-17	15:30533	PC Public Works Canada, Information Research & Library Services, Sir Charles Tupper Bldg., Confederation Heights, Ottawa, ON, CAN K1A 0M2; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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569	15:31996	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90627147	
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228702020	15:31408	Rijksinstituut voor Volksgezondheid en Milieuhygiene (RIVM), P.O. Box 1, 3720 BA Bilthoven, Netherlands			
RPA–					
80-0429(3)	15:30601	*See* PB–90-178757/XAB			
RSI–					
0359	15:30116	*See* DOE/CH/10378–5			
RU–					
89/B1/53	15:31807	*See* DOE/ER/01545–438			
89/B1/55	15:31808	*See* DOE/ER/01545–440			
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89-04	15:30323	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626781	
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89-0203	15:30143	NTIS, PC A05/MF A01; OSTI; INIS		DE90008236	MF-510
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544-PT-2	15:31684	*See* PB–90-171679/XAB			
SIM–					
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SIP–					
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0024	15:31272	*See* CNIC–00165			
0025	15:31929	*See* CNIC–00177			
0026	15:31930	*See* CNIC–00180			
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3125	15:31585	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626502	
3575	15:31454	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626503	
3581	15:30161	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626600	
3629	15:30897	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90626004	
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90-4	15:32026	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010878	MF-405
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FP15	15:30540	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
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1989-41	15:30513	NTIS (US Sales Only), PC A05/MF A01		DE90770777	
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90-02159	15:30480	PC Transport Canada, Library and Information Centre, Place de Ville, Tower C, Ottawa, ON, CAN K1A 0N5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
TES–					
89-05739	15:30254	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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313.223	15:30270	NTIS (US Sales Only), PC A03/MF A01		DE90767926	
613.006	15:30544	NTIS (US Sales Only), PC A06/MF A01		DE90767893	
618.011	15:30241	NTIS (US Sales Only), PC A05/MF A01		DE90767885	
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4457-080-89	15:31368	*See* PB–90-139627/XAB			
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1209	15:30586	*See* PB–90-173113/XAB			
TSHUNE–					
0006	15:30928	*See* CNIC–00218			
TU/CEA–					
90-00183	15:30055	PC Canada Centre for Mineral and Energy Technology, Technical Information Division, 562 Booth St., Room 20-C, Ottawa, ON, CAN K1A 0G1; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
U08-NAC–					
0024	15:30178	*See* CNIC–00284			
UCID–					
18987-90	15:31877	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010184	MF-700
21702	15:31898	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010759	
21849	15:31988	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010200	MF-712
21900	15:30168	NTIS, PC A03/MF A01 - OSTI		DE90008244	MF-702
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102438	15:31951	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010691	MF-405
102581	15:31331	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010692	
21223	15:30155	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010752	MF-702
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103173	15:31329	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010186	
103335	15:31920	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010183	MF-706
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103429	15:31952	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010283	MF-405
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103562	15:31922	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010690	MF-700
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103614	15:30771	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010634	MF-701; MF-704
103629	15:31899	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010876	MF-404
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103168	15:31675	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010194	MF-705
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1073	15:30158	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010187	PC-510
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WU-					
89-05738	15:30250	PC Energy, Mines and Resources Canada, Communications Branch, 580 Booth St, Ottawa, ON, CAN K1A 0E4; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
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3766-4-8	15:30266	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
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3766-4-22	15:30549	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
3766-4-27	15:30550	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
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IR	Iran
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IT	Italy
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JO	Jordan
JP	Japan
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KH	Democratic Kampuchea
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